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PLANNING THE LAND OF BRITAIN

THE title of the Ministry in which Mr. Harold Macmillan has succeeded Dr. H. Dalton has been changed from 'Local Government and Planning' to 'Housing and Local Government'. The word 'planning' thus disappears from ministerial titles for the first time since it was added to that of the Ministry of Works in 1942. It has not, however, been suggested that the fresh emphasis now placed on the housing responsibilities of Mr. Macmillan's office implies any shedding of responsibilities for the planning of the use of land from a national point of view, or that the National Parks Commission will no longer be responsible to him.

Planning responsibilities in Great Britain are likely to be increasingly onerous in the immediate future, and though to some extent the requirements of housing and town-planning for land may place Mr. Macmillan in an invidious position in co-ordinating rival claims for the use of land, it can be safely assumed that such functions will be discharged with good sense and imagination. Long-term national interests, which, as *Planning* has rightly insisted in a recent broadsheet on "Land-Use Planning", are the decisive element in such planning, will undoubtedly suffer if Mr. Macmillan's co-ordinating powers are no wider than those of his predecessor, and if they are not exercised with vision and energy as well as tact. Claims for the use of land in the national emergency are no less acute and conflicting than at any time during the past two decades, and unless wisely and firmly resolved may do irreparable damage to long-term interests, especially in respect of those amenities which the National Parks and Access to the Countryside Act is intended to safeguard.

Mr. Macmillan, moreover, has taken office at a time when Dr. Dalton's handling of the question of administration of the proposed parks had engendered profound scepticism as to whether any really national parks would be established. Designation orders for four of the proposed parks were signed during Dr. Dalton's term of office, and the boundaries of the Peak District, the Lake District and the Snowdonia National Parks were confirmed by him. The order designating the Dartmoor National Park has since been confirmed by Mr. Macmillan. The route for the Pennine Way was also approved by Dr. Dalton, and this fine project should now go to fruition with little need for personal attention from the new Minister, who will, however, be expected to watch over it benevolently, since in the austere conditions which the nation is called upon to face, access to the countryside may play a vital part in maintaining health and morale.

The situation as regards the national parks is otherwise, and for all the vigour with which the initial task was tackled by Dr. Dalton and the National Parks Commission, a situation has developed which threatens to frustrate the whole purpose of the Act unless the question of joint planning is firmly and promptly handled in accordance with

the pledges given in Parliament when the Bill was passed. Some disappointment has been expressed in regard to the national members appointed by the Minister to the Joint Boards for the Peak District and Lake District National Parks, on the ground that insufficient use has been made of the services of those known to possess experience, knowledge and vigour in local rural preservation; but that disappointment may not in the event prove justified, and is entirely secondary to that of the financial independence of the Joint Boards.

When, at the committee stage of the Bill, an amendment was moved which would have ensured that the finance committees of county councils whose powers were being transferred to a joint board should have no control over the board, the Minister, then Mr. Silkin, immediately stated that, once an 'order' had been made to set up a joint planning board, there would be no need to go back to the separate authorities for permission to arrange the necessary finance. It would be met entirely by precept issued on the counties by the board. The first schedule of the 1949 Planning Act specifically provides for this, and it was on this undertaking that the amendment was withdrawn. In spite of this pledge, in his 'order' establishing the Lake District Joint Planning Board, Dr. Dalton placed a limit of £7,500 on the annual expenditure of the Board, and made any increase in this figure subject in the first instance to the consent of the three county councils in the areas of which the Park lies. This figure, which is half that originally suggested as probable by the Ministry of Local Government and Planning itself, is the figure at which the county councils offered to do the work with their own officers. The order thus frustrates the freedom of the Board as regards planning, which was expressly promised in the House of Commons, together with financial independence. It is understood that the National Parks Commission has already protested to the Minister that it considers the councils' proposals to be unsatisfactory and that in its opinion the Lake District Joint Board should appoint its own planning officer, who should be wholly in its service. It is, of course, a statutory duty of the commissioners, under the National Parks Act, to advise the Minister "generally and in relation to particular national parks" as to the action needed to be taken. By the terms of the Act, too, the Commission should be consulted about such administrative matters; but this obligation seems to have been disregarded: the arrangements appear to have been concerted entirely between the Ministry and the county councils.

There is also controversy over the Joint Board for the Snowdonia National Park, where the Caernarvon County Council has been pressing for administration, in defiance of the Act, by a joint advisory committee.

This situation demands early attention and action from the new Minister. The present Government is not bound by the pledges of its predecessor when the Bill was debated in Parliament, although the division was not on party lines. The principle at stake, however, is so vital that if the nation cannot afford at present the small sums necessary to secure effective national administration of the parks, the better course would be to repeal the National Parks Act and dissolve the National Parks Commission. That at least would be an honest policy, and would not delude the nation into thinking it was enjoying something which can never be achieved under local authority administration.

There are, of course, immediate considerations to be weighed before taking such drastic action, quite apart from the reproach which future generations would rightly level at us for the irreparable loss to amenity as well as to scientific interests. As has been urged before in these columns, our scenic heritage represents a spiritual asset, which may be of great value in our struggle for economic recovery. Access to the countryside and national parks may yet prove an important factor in sustaining the health and spirit of the people, and the case for nature reserves rests in part on their contribution to the more effective use of the natural resources of Great Britain through a fuller scientific knowledge of the fauna, flora and ecology.

These considerations must be weighed by the Government, and it is to be hoped that there will be no hesitancy in dealing with the situation which Dr. Dalton's dubious administration has encouraged. Let there be either repeal of the National Parks Act with a straightforward statement as to why the nation cannot afford the sums required to administer the parks, or firm administration of the Act in accordance with the terms laid down and the undertakings given in Parliament. County councils cannot be relied on to formulate and pursue a national policy—and indeed it is unfair to expect it of them. Their co-operation and local advice are none the less essential, and without them the national parks will not be fully effective. The devising and implementing of a national policy, however, belongs to another sphere, and confusion and frustration are liable to result if the two are mixed.

SCIENCE AND RELIGION

Natural Science and the Spiritual Life

Being the Philosophical Discourse delivered before the British Association for the Advancement of Science at Edinburgh on 12 August 1951. By the Rev. John Baillie. Pp. 44. (London, New York and Toronto: Oxford University Press, 1951.) 5*s*. net.

THE Philosophical Discourse delivered before the British Association at Edinburgh this year has one distinction which has not always been possessed by such compositions—it is really philosophical. It deals with a subject which is both relevant to the concerns of the British Association and of fundamental importance—the relation between science and religion. Those who know Dr. J. Baillie's writings will expect to find learning and literary grace happily wedded, and they will not be disappointed. "Can two walk together except they be agreed?" is the text of the discourse; but there is a subsidiary text

from the Phædo, in which Socrates recalls his early interest in natural science and the reasons which led him to abandon these studies. The thesis which Dr. Baillie develops and defends is that there is no inherent conflict between religion and science; but they cannot be brought into a harmonious relation by assigning one field of our experience to science and another to religion. "Nowhere is it possible to draw an iron curtain across the field of our experience and proclaim either the exclusion of science from the one side or its totalitarian right on the other. What we have to do with is rather two diverse ways in which the whole territory of our human experience may be approached and explored."

The thesis is elaborated by a rapid but illuminating survey of later Western thought from the point of view of the two types of causation, 'efficient' and 'final'. We cannot follow the argument in detail here. No doubt it will raise questions in many readers' minds, as the author intended. Two may be mentioned. It is not quite clear whether Dr. Baillie would draw a distinction between religion and theology and, if so, how he would define it. This is important, for the conflicts between religion and science have for the most part been, in fact, between theological doctrines and scientific theories. One can imagine, indeed one knows, scientific men who claim to have a religious approach to experience but reject the theological propositions which are presented by Christianity or any other religion for their belief. Dr. Baillie, again, has much which is most interesting to say on the Christian origins of natural science. He holds, with many other eminent philosophers and historians, that but for Christianity there would have been no science. I think we must agree that the Christian world-view did, in fact, prepare the way for the scientific method by its destruction of the ancient cyclic conception of existence and that its doctrine of God had something to do with the evolution of the ideas of the uniformity of Nature and natural law; but I find it difficult to believe that apart from Christianity the Western mind would never have hit upon the plan of investigating Nature by observation and experiment. After all, many of the presuppositions of natural science are present in Lucretius. But I have Whitehead, Berdayev, Ritchie and Foster, as well as Dr. Baillie against me. Dr. Baillie has written a stimulating pamphlet which deserves to be pondered and discussed. W. R. MATTHEWS

GLASGOW CHEMISTS

An Eighteenth Century Lectureship in Chemistry

Essays and Bicentenary Addresses relating to the Chemistry Department (1747) of Glasgow University (1451). Edited by Dr. Andrew Kent. (Glasgow University Publications, 82.) Pp. xv+233+19 plates. (Glasgow: Jackson, Son and Co., 1950.) 21*s*. net.

IN 1747 a lectureship in chemistry was instituted in the University of Glasgow and was first held by the famous teacher of medicine, William Cullen, followed by Joseph Black, John Robison, William Irvine, Thomas Charles Hope, Robert Cleghorn and Thomas Thomson. Soon after Thomson's appointment the lectureship was elevated to a regius chair, and this chair, it is stated, was "the earliest (1818) for chemistry, *tout simple*, in the country". The present incumbent, Prof. J. W. Cook, contributes a useful foreword to the book now under notice. In 1919 the Gardiner chair of chemistry was added, which Prof. J. M. Robertson now occupies. Dr. Kent points out that the Chemistry Department at Glasgow "in its first century was conducted single-handed and at times, indeed, only as an adjunct to other duties". A list is given of appointments to all grades of the academic staff of the Department up to the session 1947–48.

The scope of the book can be partly gauged by the subjects of the addresses and essays (and their authors) forming its chief contents: the lectureship at Glasgow (Dr. Kent); William Cullen's history of chemistry (Dr. Kent); Glasgow University in the eighteenth century (Prof. J. D. Mackie); Hermann Boerhaave and Scottish chemistry (Dr. Archibald Clow); William Cullen, M.D., and his times (Dr. Douglas Guthrie); phlogiston, caloric and heat (J. C. Gregory); Joseph Black, M.D.—the teacher and the man (Prof. John Read); Black's influence on chemistry (Dr. John A. Cranston); the industrial development of Scotland in the Cullen–Black period (Alexander Fleck); John Robison, M.A. (Sir Edmund Whittaker); James Watt and Glasgow University (Robert C. Howie); William Irvine, M.D. (Dr. Kent); early scientific links between Scotland and America (Dr. J. A. V. Butler); Thomas Charles Hope, M.D. (Prof. James Kendall); Robert Cleghorn, M.D. (Dr. George Thomson); Thomas Thomson, M.D. (Prof. J. R. Partington); some observations and an anecdote [Black and the teaching of chemistry, and Thomas Thomson] (the late Prof. T. S. Patterson); the chemical laboratory at Glasgow sixty years ago (the late Dr. Robert Broom); and Glasgow chemistry in the twentieth century (Prof. A. R. Todd). A prodigious amount of information is elegantly and most readably set forth. Numerous references to original sources, often extremely recondite, form a unique and invaluable collection.

It is almost inevitable that some controvertible statements have occurred in dealing with so much material. Thus, the unqualified assignment of 1774 as the year of Scheele's independent discovery of oxygen (p. 104) will surprise many. According to Nordenskiöld's researches, Scheele may have prepared oxygen as early as 1771; therefore then, or soon after, he may have observed its properties sufficiently to merit the use of the word discovery. In my opinion it seems impossible on available evidence to decide on any particular year whatsoever. On pp. 101–102 it is stated that Black discovered magnesium oxide, whereas even in his own famous paper some of the previous work of the great Friedrich Hoffmann is cited, including the ignition of what we now call magnesium nitrate, whereby the oxide is formed. Although magnesium compounds had been observed even before the investigations of Hoffmann, it is to him that the first clear and thoroughgoing publication of their characteristics belongs, based largely on his own admirable experiments. He clearly differentiated between magnesium and calcium oxides. But Black's epoch-making contributions to chemistry tower high above the discovery of magnesia. On pp. 157–8 a brief account of the early history of strontium contravenes the evidence assembled by Prof. Partington about this subject (*Ann. Sci.*, **5**, 157; 1942. **7**, 95; 1951). It was not Hope, but Crawford and Cruickshank, to whom is due the first known isolation of a strontium compound, the (hydrated) chloride. The treatment of

the discovery of the oxide also requires considerable revision. In referring to achievements of Black's students, the statement (p. 46) that "Smithson Tennant developed the backward Cambridge school" is misleading, as his contact with Cambridge as a teacher was very brief. Appointed professor of chemistry in May 1813, he apparently delivered only one course of lectures, in April and May 1814. These lectures were probably excellent; but he died the next February on the Continent, where he had been for the preceding five months. As to the backwardness of Cambridge (presumably compared with Glasgow) at the time, this seems open to question, but I am unable to express an opinion based on enough study.

Partly in jest, one might say that the last three of the examples quoted give grounds for suspicion that respectable reverence for local gods has unwittingly influenced investigation and appraisement of their deeds. Be that as it may, every recorder of facts and their interpretations is liable to various psychological influences which he must guard against. This well-known fact should constantly be remembered, perhaps especially earnestly in these times.

It is hoped that the usefulness and charm of this book will be so widely recognized that future editions will be demanded. As well as corrections of textual errors, another desirable improvement would then be possible—in the indexes, where mentions of some persons in the text are not recorded, and those of others often only partially. There is something to be said for no index at all, rather than one having the air and intention of completeness which in fact it is far from achieving. A searcher relying on the latter kind may be denied information to be found, though with unnecessary difficulty, from reading the text.

Altogether, this is an indispensable text-book for students of the Cullen–Thomson period. Its price is moderate for the feast of knowledge and entertainment it affords.

L. F. Gilbert

UNITARY BIOLOGY

Cell and Psyche

The Biology of Purpose. By Edmund W. Sinnott. (John Calvin McNair Lectures.) Pp. ix+121. (Chapel Hill, N.C.: University of North Carolina Press; London: Oxford University Press, 1950.) 16*s*. net.

PROF. E. W. SINNOTT'S thoughtful and stimulating book is based on one forthright, far-reaching thesis. "The position which I wish to defend . . . is briefly this: that biological organization (concerned with organic development and physiological activity) and psychical activity (concerned with behaviour and thus leading to mind) are *fundamentally the same thing*" (p. 48). "It is this organization . . . which, *as experienced by the organism*, I believe to be the simplest manifestation of what in man has become conscious purpose" (p. 53). Sinnott is, of course, not the first to make suggestions of this kind. Somewhat similar attempts to avoid a bifurcation of Nature by refusing to admit the existence of a dualism are found in philosophies as different as those of Whitehead, the *Gestalt* school and Marxism. Sinnott's characteristic contribution is that he approaches the subject as a student of development. His professional biological interests bring him into immediate contact with those processes in which a young organism is driven by its own internal constitution towards the realization of a specific end, the adult state—processes which strongly suggest a parallel with those carried out by man under the guidance of a conscious purpose. Thus, whereas most authors who have thought on these lines have been perhaps most interested in the problem of knowing, Sinnott is particularly concerned with the problem of will.

It would certainly seem that, if we are ever to transcend the defeatist dualism of the conventional outlook on biology, Sinnott has indicated the general direction in which to seek a way of bringing the subjective experience of purpose into relation with material events. There is no doubt that, particularly during embryonic development, biological systems do sometimes get into states which result in a tendency for change to occur in a definite direction. At present, the examples of such states about which we know most do not involve the fully differentiated nervous system, but more simple systems in earlier stages of development. There is, however, no reason to deny that similar situations of 'competence' might arise in the brain, and it would be to such conditions that Sinnott would look to find the physical basis of will.

After developing these ideas in the first two chapters, in the third Sinnott mentions briefly their relevance to some of the classical problems of philosophy. He attempts rather to show that his outlook may lead to a new formulation than to provide ready answers. Thus on p. 89 he writes, "The real issue in the problem of freedom is again the fundamental character of biological organization, of what it is that sets up self-regulating mechanisms in a living thing, and ultimately in the nervous system of man, and which thus creates purposes and fulfils them in action". This is hinting, surely, that there may be some close parallel between the 'spontaneous' formation of a purpose (that is, free will) and the sudden arising of a previously non-existent crystal order when two suitable types of molecular species happen to come together in a liquid—a bizarre thought, but perhaps not entirely unworthy of turning over in the mind. It is certainly a stimulating book.

C. H. Waddington

QUANTUM THEORY OF MOLECULES

Structure of Molecules and the Chemical Bond

By Y. K. Syrkin and M. E. Dyatkina. Translated and revised by M. A. Partridge and D. O. Jordan. Pp. ix+509. (London: Butterworths Scientific Publications, Ltd., 1950.) 63*s*.

ALTHOUGH the quantum mechanical treatment of atomic and molecular structure is now universally accepted, remarkably few monographs on the subject have yet appeared. This book, by Y. K. Syrkin and M. E. Dyatkina, has already achieved recognition in its original Russian version, and the appearance of an English translation is therefore an event of some interest. During translation, certain additions and revisions have been made, and the intention evidently has been to provide a comprehensive and authoritative account of the subject for Western readers.

Certainly the field has been covered comprehensively, and the text is sprinkled with useful tables and numerous references. These seem well chosen, although they show a certain bias to the Russian literature. Most of the treatment is qualitative, resting on the familiar resonance theory; but the mathematical basis of the theory is also discussed in some detail. The style is adequate, and the book is well produced and well indexed.

Unfortunately the authors have failed to make good use of their material and the book cannot be regarded as a success. In the first place, it seems to lack co-ordination, the chapters giving the impression of unplanned and disconnected essays. Thus most of the treatment of the Periodic Table in Chapter 2 rests on ideas of valency which are not discussed until Chapters 3 and 4, and spectroscopic notation is introduced in passing without any explanation. Again, there is a tendency to condense discussions of fundamental principles and enlarge on irrelevant details; an example is the brief 'explanation' of resonance at the beginning of Chapter 5, followed by a digression on Rumer's theorem and a list of the forty-two canonical structures of naphthalene. Finally, the mathematical parts of the book seem particularly inept; some sections are obscured by vast smoke-screens of unnecessary algebra (the Heitler–London treatment of H_2^+ is a good example), while others suffer from ellipsis and lack of explanation (cf. the sudden introduction of the secular equation on p. 412).

There are various minor errors and omissions in the text; for example, diethoxymethylene (p. 113) does not exist, the bond-lengths quoted for dibenzyl (p. 76) are old and incorrect values, and the statement that coplanarity is essential for resonance (p. 95) is fallacious. There are some misprints; for example, the omission of two exponents in Table 4, an incorrect resonance energy for chrysene in Table 113, and Mullian (corrected to Mullikan a few lines later) on p. 133.

In short, this book cannot be recommended either as an authoritative text or as a suitable introduction to the subject. More experienced readers will find in it much useful factual information. The price seems high.

M. J. S. DEWAR

PHYSICS FOR GENERAL HONOURS STUDENTS

Physics

By S. G. Starling and Dr. A. J. Woodall. Pp. xvi+1301. (London, New York and Toronto: Longmans, Green and Co., Ltd., 1950.) 42*s*. net.

THE publication of a comprehensive text-book for students covering the whole subject of physics up to general honours degree standard is an important educational event, and in the short time since it appeared there have already been signs of the cordial reception that this enterprise has deserved. Any volume of this standard planned to supplement lectures and give guidance to students would in these days of large classes and pressure on tutorial and library resources serve a useful purpose and be sure of a welcome. It is all the more gratifying to find that usefulness has not been submerged in the restricted principle of utility, and that the book can be recommended on its merits alone as an excellent companion for students, which is both sound in content and readable in presentation.

A good deal of elementary work is included, and it is a wise plan to take nothing for granted, for there can be few students who enter on work at this level with a full grasp of all that they are supposed to have mastered earlier; but this is presented in a way that will appeal to the maturing reader, and make him draw on his own resources instead of sending him back to refer to a first-year university text-book. Of the main contents, the electricity and magnetism portions follow the general lines of Mr. S. G. Starling's classic text-book for degree students, and the earlier chapters on the properties of matter again adopt the treatment that he has used successfully in the past, though to a slightly more advanced standard than in his earlier book. The sections on light, particularly the chapters dealing with physical optics, are well done, and the treatment of interference and diffraction is admirable; it is appropriate here to go fairly fully into details, since the elementary teaching at the school or intermediate level seems all so simple and almost complacently rounded off that the student's chief difficulty with more advanced work is to appreciate the physical necessity for a fuller mathematical treatment. The authors have here presented things so skilfully that the transition from what one might call the schoolboy outlook to the more exacting approach of university work comes naturally in the course of the text. The illustrations to this part of the book are helpful, and very well executed. The chapters on heat are perhaps a little below the standard of the rest; this is my opinion, which is based on a feeling that thermodynamics, as the most important of tools and the hardest with which to acquire proficiency, might well have been allotted more space. Other readers may possibly feel that a case could be made for a fuller treatment of this or that particular point; and criticism of this kind is no reflexion on the merit of the book, but rather emphasizes the high quality of what is actually provided, and the discretion and restraint with which the authors have aimed at, and preserved, a very uniform standard throughout the greater part of their work.

There are numerous references to modern developments in optics, electricity and atomic physics, and the principles involved are explained as fully as is desirable at this standard; but experimental details and matters of technique are wisely left for the student to seek elsewhere. This again is very laudable: people at this stage in their careers can stand on their own feet, and use initiative in pursuit of knowledge; but are often all too ready to use a text-book as a crutch if it is comfortably padded.

The first chapter gives a summary of the mathematical equipment required, and at the end of the book there are mathematical tables and a comprehensive list of physical constants. There is a collection of searching examination questions, and also, what is essential in a book of this size, an efficient index. Binding and production are good, and every device by which space may be saved without irritating the reader seems to have been adopted effectively, so that there is really more matter in the book than the respectable total of thirteen hundred pages suggests. At two guineas, in these days, it is very good value for money.

G. R. NOAKES

Inferiority Feelings in the Individual and the Group

By Oliver Brachfeld. Translated from the French by Marjorie Gabain. Pp. 301. (London: Routledge and Kegan Paul, Ltd., 1951.) 25*s*. net.

THIS book was written in Spanish by a Hungarian, translated into French and re-translated from the French into English. One might have expected from such metamorphoses that the result would be unintelligible; but so carefully has the translator, Marjorie Gabain, done her work that the text reads as if it had been written directly in English. The book is an attempt to show the historical emergence of Adler's ideas in such precursors as Montaigne, Hobbes, Mandeville, Vauvenargues, and so on, then the views of Adler himself, and finally their application to the individual and to society. The author draws on innumerable sources, both medical and literary, and is obviously widely read in most European languages. Most of the exposition of Adlerian principles merely follows the lines laid down by that school; but it is done in an interesting way. In some cases it is superficial and even contradictory; for example, the author is willing to accept the results of questionnaires regarding the superficial causes of inferiority, but he refuses to accept the fact that few musicians are deaf as a refutation of the Adlerian principle that musical ability is the result of over-compensation, as put forward by Elsa Bienenfeld.

The most interesting and original part of his book is the attempt to apply the theories of individual psychology to such problems as industrial disputes. It is long past time when psychologists should have made studies of the deeper causes of strikes and lock-outs, not from the point of view of benefiting either the employers or the employees, but to prevent them and the consequent disruption of society. A knowledge of the deeper causes of industrial warfare may help to prevent international disputes and the wreckage of society. Attempts, such as the author's, to understand the psychology of national feeling may finally give us a deeper knowledge and lead to prevention of war.

This book is a sound exposition of the Adlerian point of view and will interest those who find Adler's work satisfying. It is excellently produced, the paper is good, the print clear, and the binding in brown with gold lettering unobtrusive.

CLIFFORD ALLEN

The Electrical Activity of the Nervous System

A Textbook for Students. By Dr. Mary A. B. Brazier. Pp. x+220. (London: Sir Isaac Pitman and Sons, Ltd., 1951.) 25*s*.

THIS short text-book gives a useful elementary introduction to the electrophysiology of the central and peripheral nervous system and of the sense organs. Considerable knowledge of anatomy and physiology and some knowledge of elementary physics are required of the reader. The earlier chapters, which deal with the electrical properties and general physiology of peripheral nerve and of the spinal cord, are less detailed and self-contained than are the later ones, in which the peripheral and central sensory apparatus and the spontaneous electrical activity of the brain are described.

In these later chapters, the book ranges rather more widely and goes a little more deeply into its subject-matter than do the relevant sections of the standard texts on physiology. Medical students will find in it interesting supplementary reading. Those embarking on advanced courses in physiology will not need it beyond the early stages of their work in electrophysiology, but they will find the bibliographies useful. The book will be specially valuable to those physicists who are nowadays being attracted into the field of applied electrophysiology. Parts of it would interest general biological and scientific readers.

The writing is admirably clear, the presentation that of a gifted teacher and the many illustrations have been wisely chosen.

The Physics of High Pressure

By Prof. P. W. Bridgman. (International Text-Books of Exact Science.) New impression, with Supplement. Pp. viii+445. (London: G. Bell and Sons, Ltd., 1949.) 35*s*. net.

THE main achievements of the past twenty years in the high-pressure field are described in a supplement of some forty pages, which is the chief addition to this new impression of Prof. P. W. Bridgman's standard work. Although this method of revision was probably dictated by the photographic process used, no happier way could have been chosen; for the story of the author's own monumental researches is continued beyond the range of pressures reached in the work of the original volume, up to 100,000 kgm./cm.^{2} in many cases, and this is the natural sequence to adopt. A number of new problems, such as the behaviour of metals under shear and plastic deformation at high pressure, are discussed as well as extensions of earlier investigations.

The only alteration in the body of the earlier text is in the section on the compressibility of the alkali metals. In 1931 it had seemed worth while to look for indications of the breakdown of atomic structure under the pressures then attainable. Redetermination of the values, and their extension to the highest pressure range, still fail to reveal any premonition of such breakdown, though in the case of cæsium two interesting discontinuities in the pressure–volume curve are recorded.

Apart from its uncontested authority as the work of reference on this subject, this is a book which the physicist with less-specialist intent can read with profit. It is a story of difficulties sought out and hunted down, written in a style which reveals the author as one of the calmest and most equable of experimenters. His comments and discussion are rich in scientific wisdom, and it is good to see the book once again in print.

Scientific Survey of South-Eastern Scotland

Prepared for the Meeting held in Edinburgh, 8th to 15th August 1951. Pp. 208. (Edinburgh: British Association Local Executive Committee, The University, 1951.) 15*s*.

THIS book was prepared in connexion with the meeting at Edinburgh this year of the British Association for the Advancement of Science, and, on the lines of surveys for other years of the locality around previous meeting-places of the Association, it gives a comprehensive but succinct account of the history, social conditions and economy of south-east Scotland as well as its scientific features, natural and otherwise. The area covered is made up of the counties of Fife, Kinross, West Lothian, Midlothian, East Lothian, Peebles, Berwick, Selkirk and Roxburgh

—that is, roughly speaking, all the land from the Cheviot Hills to the Firth of Tay lying on either side of the Firth of Forth. The book is divided into twenty-one review articles, each by a local authority and dealing respectively with the following topics: south-eastern Scotland—the region and its parts; weather and climate; prehistoric settlement; the Roman period; medieval times; 1500–1950; growth of Edinburgh, 1128–1800; growth of Edinburgh, 1800–1950; public health; influence of man on plant and animal life; agriculture; mining; manufacturing industries; changes in rural life and landscape, 1500–1950; population; transport; education; University and colleges of Edinburgh; the outlook; geology; research institutions. To complete the work a Bartholomew quarter-inch coloured topographical map is included, tucked into a flap on the inside of the back cover.

In the space of a short note it would be invidious to select any particular item for detailed comment, but perhaps it might not be inappropriate to say that, since paper-making and printing and book-binding are mentioned as among the principal industries of Edinburgh, one could expect that the production of this book would be of a high standard—and one's expectations are fulfilled. As befits the capital city of the northern half of the Union (and there are some, Sassenachs included, who would describe it as the fairest city of the Union) a good proportion of the space is devoted to Edinburgh itself; but a capital city is not the be-all and end-all of a country, and it can be fairly said that south-east Scotland as a whole has received its due share.

While the appeal of this type of survey is necessarily limited to those with ties to the immediate locality in question, nevertheless the members of the British Association who conserve these annual volumes thereby collect an authoritative collection of material pertaining to the principal centres of Great Britain, and this volume is second to none in this series.

Introduction to the Patenting of Inventions

By Cecil Hollins. Pp. 99. (London: Ernest Benn, Ltd., 1951.) 4*s*. 6*d*. net.

MR. CECIL HOLLINS and his publishers are to be congratulated on producing in ninety-nine pages and for 4*s*. 6*d*. such a concise and straightforward account of the essentials of that complicated and important field of law—British patent law. Mr. Hollins is exceptionally well equipped for producing such a book. For many years he was head of the Patent Department of the Imperial Chemical Industries, Ltd., and he has also had a wide experience on patent and related matters in Great Britain and abroad. He is therefore fully aware of the needs of scientific and technical persons in relation to the important questions of patents, and this book should make a great appeal to inventors and persons engaged in research generally and to members of the staffs of industrial firms.

In January 1950 the Consolidated Patent Act, 1949, came into force and made many important changes in patent law. Most of these amendments had been recommended by the departmental committee on patents presided over by Sir Kenneth Swan. Mr. Collins's book deals briefly with all the provisions of this Act. Chapters 1 and 2 deal with questions likely to arise in the course of prosecuting patent applications, and Chapter 3 is concerned with questions after a patent is granted. In Chapter 4 he indicates briefly the grounds upon which a patent may be attacked for invalidity.

The book is well set out, with the main headings printed in heavy type, and marginal references to the sections of the Act are included in the text. For a small book of this kind, the index is exceptionally good, and an attractive feature is that this index refers both to the pages of the book and to the sections of the Act. It is therefore a complete index to the Act, irrespective of the contents of the book. There are references to some important court cases, but the book has the advantage of not being cluttered up with references to many cases which the new Patent Act has put out of date. R. G. LLOYD

Australian Fisheries

A Handbook prepared for the Second Meeting of the Indo-Pacific Council, Sydney, April 1950. Edited by I. G. MacInnes. Pp. 103+6 plates. (Sydney: Commonwealth Fisheries Office, 1950.) n.p.

THIS handbook gives a balanced and informative picture of a young and vigorous fishing industry expanding in spite of the handicap of a general low level of productivity in the surrounding seas. The freshwater fisheries of Australia are of little importance; but the estuarine fisheries are very important, so much so that it is a pity that statistics for these fisheries are not given. The deep-sea trawling and seining fisheries contribute 16 million out of an estimated total production of some 91 million pounds of fish in 1948–49; it is the distribution of the balance which would be so informative, and one has to search through the text for such statistical data as are given.

The lack of statistical tables, however, is the only criticism in a most useful booklet. The fine work being done by the research staff is summarized; in more than one instance this research has led directly to new fishing industries.

The distribution of the existing fisheries is shown, and explained in terms of produce and markets. The expansion of canning and freezing may, however, open up fisheries in sparsely populated areas, as has already happened in the case of Tasmania. Six useful plates illustrate the principal Australian fishes of commercial importance. C. F. H.

Journal of the Institute of Metals

Editor: Lieut.-Colonel S. C. Guillan; Assistant Editor, Major W. G. Askew. Vol. 75, 1948–49. Pp. lii+1230+138 plates. (London: Institute of Metals, 1949.) 60*s*.

THE Institute of Metals attempts the difficult task of providing a society to serve the interests of those concerned with the industrial side of non-ferrous metallurgy, and of purely scientific workers. The present volume shows how admirably this dual function is fulfilled on the publication side. It contains fifty-four papers covering such a wide range that any metallurgical reader will find much of interest. The standard of printing and illustration is high, but the volume of 1,230 pages is far too bulky and should have been split into two parts or separate volumes; the bound copy sent for review will rapidly become detached from its cover in the course of normal laboratory use. The papers include six contributions to a symposium on metallurgical aspects of non-ferrous metal melting and casting of ingots for working, and apart from this the wide range of subjects is remarkable. W. HUME-ROTHERY

INSECT PHYSIOLOGY AND APPLIED ENTOMOLOGY

A MEETING of the Association of Applied Biologists, held in the rooms of the Royal Entomological Society of London on October 12, was devoted to "Insect Physiology in Relation to Applied Biology". Dr. V. B. Wigglesworth was in the chair.

In opening the discussion, Dr. Wigglesworth claimed that insect physiology makes no direct contribution to applied entomology. The control of insect pests by biological methods is based upon ecology; but a proper understanding of the ecology of an insect is impossible without a knowledge of its physiology. The practical value of this knowledge lies in the new ideas that it gives to the applied entomologist. Similarly, all the greatest discoveries in the use of insecticides have been made empirically. But the subsequent study of the diverse physiological mechanisms involved in insecticidal action has served to codify our knowledge, to put it on a rational basis and to point the way to further advances.

The study of insecticidal action may be pursued at three levels: the uptake of insecticides from the environment, their passage through the protective coverings of the insect or its egg, and the intervention of insecticidal poisons in metabolism. Dr. W. A. L. David discussed the physiological and anatomical factors involved in the accumulation of contact insecticides. The movement of the insect plays a most important part; and, as Dr. E. A. Parkin pointed out later in the discussion, the insecticide may itself influence the insect's movement and so the quantity of poison it acquires. Insects walking on a treated surface will pick up increased amounts of poison. The fine droplets that compose insecticidal mists will strike the insect only if they have sufficient momentum or if the insect itself is moving rapidly enough. They are, indeed, effective as a rule only if the insect is in flight, and, since the wings of flies or mosquitoes commonly move at least ten times as fast as the body, by far the greater number of droplets are taken up by the beating wings. Many different factors have to be considered in the accumulation of insecticidal dusts by insects. Some dusts are physically bulky, others dense; and the appearance of the treated insect may give a totally misleading impression of the weight of dust accumulated. In the case of rough or hairy insects, large amounts of the dust collected may be quite out of contact with the effective sites of entry; and with a single species of insect the same amount of the active principle accumulating on the body may be more effective when associated with one carrier than with another, because the shape of the dust particle has an important influence in ensuring contact with the vulnerable areas.

Dr. J. W. L. Beament pointed out that recently acquired knowledge of the structure of the cuticle and egg-shell of insects goes some way to explain the variable toxicity of contact poisons. In both the cuticle and the egg-shell a thin layer of wax forms the most important barrier; an insecticide must dissolve in wax and have a suitable partition coefficient between oil and water. Local differences in the structure of the membranes demand detailed study. In the egg of Heteroptera, for example, the general surface is totally impermeable to the most potent poisons. But around the rim of the cap are respiratory ducts containing an air-filled, spongy substance leading to a thin layer of the same air-filled material lining the shell. Insecticides with suitable wetting properties will readily fill layers of this type, which are of common occurrence in insect eggs, and they are then separated from the contents of the egg only by the thin wax layer. Some eggs deposit a further layer of impermeable material inside the wax. The formation of this layer may be correlated with a great increase in the resistance of the egg to insecticides when it reaches a certain age. It may become susceptible again in the late stages of development when this inner membrane is dissolved; or the embryo may be poisoned by the quantities of insecticide that have been held in this protective membrane and liberated during its solution. Clearly the age of eggs must be most carefully controlled in making ovicidal tests.

Dr. C. Potter described a number of researches by himself and his colleagues, Dr. K. A. Lord and Dr. A. H. McIntosh, which served to illustrate some of the physical and biochemical factors concerned in insecticidal action. The size of particles of an insecticide applied externally may greatly influence the toxic action. Small particles of rotenone are several hundred times more toxic than layer particles. With DDT the difference is less evident—perhaps because it is so much more soluble in the lipoid layer of the cuticle that its rate of entry is not greatly influenced by being in finely particulate form. The same correlation between the effect of particle size on toxicity, on one hand, and lipoid solubility, on the other, is seen when the poisons are injected into the blood stream. Temperature may influence the toxic action of insecticides in several quite different ways. Pyrethrins, DDT and some other poisons are much more toxic if the insects are kept at a low temperature after spraying. This is mainly an effect on metabolism. But at high temperatures insects move more actively; they may therefore pick up more of the insecticide from the environment and thus show an increased mortality at higher temperatures. Moreover, at low temperatures the more rapid solubility of small particles is accentuated so that their relative toxicity is even greater. The action of insecticides in metabolism was illustrated with reference to the organo-phosphorus compounds. These are powerful inhibitors of choline-esterase, and when an analogous series of organo-phosphorus insecticides is examined there is a partial correlation between choline-esterase inhibition and toxicity. But there are other esterases present in insects which do not hydrolyse acetylcholine, and it has been found that these also are inhibited by the organo-phosphorus insecticides; and it may well be that this effect is involved in their insecticidal action—for example, when they kill insect eggs at an early stage of development. A knowledge of the differences between the esterase systems of insects and mammals might serve as a basis for selecting chemicals toxic to insects but relatively non-toxic to man.

The interrelations between physiology, ecology and cultural control were illustrated and discussed with reference to the sheep tick *Ixodes ricinus*, an important

carrier of a number of serious diseases in sheep on hill farms. Dr. A. Milne described the general features in the ecology of this tick. It is widely spread throughout the hill sheep-farming areas of Great Britain, but occurs only in those localities where the pastures are rough, with a thick layer or 'mat' of dead and dying vegetation at the base of the herbage. The humidity in this mat is always about 100 per cent, and it appears to be this high humidity which is the limiting factor in the distribution of the tick. This is not surprising when it is realized that the sheep tick is not resistant to desiccation, and yet during its life-cycle of two to three years it spends only about six weeks in feeding on its host. For the rest of its life it is lying inactive in the moist mat or is at the tips of the grass stems waiting for a passing host. In most of the country there is only one period, in the late spring and early summer, during which the ticks are active in this way. But there are some localities, notably in the west of England, where there is a second peak of activity in the autumn. (An apparent peak in the summer which has been described in Wales is spurious and has been wrongly inferred from the gradual rise in the numbers of ticks upon stock introduced to infested pastures.) Pasture improvement, with the elimination of the humid 'mat', will effectively eradicate the sheep tick—though this is seldom economically practicable on the hill farms.

Dr. J. Allan Campbell described his detailed studies of the developmental cycle of the sheep tick in Nature. The temperature in the natural environment ranges between −2° C. and + 15° C. At these temperatures development and egg-laying proceed at much slower rates than has been inferred from studies in the laboratory. In the normal cycle the tick at each stage of its development feeds in the spring or early summer, moults or oviposits during the summer, and overwinters in the unfed state. But there is a second cycle in which the ticks feed in the autumn, pass the winter in the egg or in the engorged state, and hatch or moult in the spring. It is these two populations, between which there seems to be little interchange, which are responsible for the two peaks of activity in the spring and in the autumn. The threshold temperature for development of the egg is 7° C.; but the eggs laid by the ticks of the autumn feeding cycle will not develop, even at 10–20° C., until they have been exposed to severe cold for a good many weeks.

The physiology of the sheep tick, as described by Dr. A. D. Lees, goes far towards explaining the observations made on its ecology. When compared with a series of other ticks, *Ixodes ricinus* has a cuticular wax of very poor waterproofing powers, and it is this which limits its distribution. The closely related dog tick *Ixodes canisuga*, which has a cuticular wax of higher melting point, is alone able to survive in the kennels of the sheep dogs, although both species are picked up by them. So long as *Ixodes* remains in a nearly saturated atmosphere, it can absorb water vapour actively through its cuticle and maintain its water content. When it becomes active in the spring, the unfed tick shows a negative response to gravity and an avoidance of high humidity which lead it to the tips of the grasses, where its sensitive responses to vibration, to passing shadows and to eddies of warm air and smell enable it to cling to a passing host. The unfed tick at each stage of its life-cycle can remain latent in the humid mat for many months. The length of time it can resist starvation is determined by its reserves of fat carried over from the previous stage. After becoming active and resting for some time at the tips of the grasses, it loses moisture and it then returns to the mat to restore its water content by the active uptake of water vapour. This form of activity is necessary if the tick is to secure a meal to enable it to grow or reproduce. But it soon exhausts the limited reserves of fat, and the active tick dies of starvation far sooner than the more sluggish individual which remains dormant at the base of the vegetation.

In closing the discussion, Dr. Wigglesworth said that the sheep tick problem was chosen because it illustrates particularly well the way in which a knowledge of the detailed physiology of a pest enables the applied biologist to think clearly and rationally about it and to see his problems in a new light. That is part of the debt of applied entomology to insect physiology. But there is a debt of perhaps even greater magnitude in the other direction. Many of the most important discoveries in insect physiology, and indeed in biology in general, have resulted from the intellectual stimulus of contact with some practical problem.

BUILDING RESEARCH CONGRESS, 1951

THE Building Research Congress held in London during September 11–20 was the outcome of co-operation between some two-dozen professional institutions and trade federations interested in building and civil engineering construction, the Department of Scientific and Industrial Research and the Ministry of Works. As the first of its kind ever to be held, it aroused much interest both in Great Britain and overseas, and among its 1,400 members were representatives of more than fifty countries; of the eighty-eight papers presented forty-five were by authors from outside Great Britain. The enthusiasm with which the Congress was greeted was a clear indication of the need for such a conference, and the large attendance from abroad was a tribute to the regard in which the pioneer work of Great Britain in this field is held. The Congress, the organization of which was largely undertaken by the Building Research Station of the Department of Scientific and Industrial Research, met under the presidency of Lord Samuel.

The opening session, held at the Institution of Civil Engineers on the morning of September 11, was the occasion of the first of Lord Samuel's thought-provoking contributions. He directed attention to the effect environment—man-made as well as natural—has had on individuals and pointed out the effect that building research could therefore have on individual and national life. Dr. F. M. Lea, director of building research in the Department of Scientific and Industrial Research, traced the growth of organized building research and made a plea for still closer co-operation of industry in the application of its results. In the afternoon members were the guests of the Government at a reception at Lancaster House, and later, under the auspices of the Parliamentary and Scientific Committee, visited the new House of Commons Chamber and other parts of the Palace of Westminster.

For the technical sessions, the Congress was organized in three divisions, dealing with the engin-

eering and constructional problems, with building materials, and with the factors affecting the use of buildings. For most of the period of the Congress there were thus five concurrent sessions; the papers, all of which had been specifically invited, had been circulated before the Congress and were therefore only briefly introduced, so that most of the time was available for discussions, which were at all times lively.

The first two sessions in Division 1 were devoted to papers dealing with the influence of mechanization and prefabrication on techniques and cost of building. After a general review had been given by R. Fitzmaurice (Great Britain), there were papers from Holland, the United States and France, on the latest developments in the building of dwellings in these countries. It was apparent that there is still a good deal of work in progress on non-traditional construction. Research into the use of mechanical aids in building operations was covered in a paper dealing with work in Great Britain, and it was pointed out that the full application of aids of this sort has yet to be effected. The last paper in this group was from Switzerland and dealt with the changes which new building methods bring into design and drawing-office procedure. Perhaps the main feature brought out in the discussion of this group of papers was the slow effect innovations have on the structure and techniques of so traditional an industry.

Three sessions were then devoted to the influence of modern research on structural design, in which a general review paper was given by Prof. G. Wastlund (Sweden). A group of four papers dealt with research on the use of concrete in structures, and considerable interest was aroused particularly in the two papers in this group which dealt with pre-stressed concrete and the design and use of thin concrete shells. A further four papers dealt with research into the use of steel in structures; and these papers covered such points as the way in which research has been helping the designer, research on structural steelwork particularly with reference to the behaviour of structures beyond the elastic range, and the application of welding in steel structures. A third session in this group was devoted to timber and light alloys; in this session there was a paper dealing with the modern development of the use of glued laminated timber as a structural material.

The final two sessions in Division 1 were concerned with the influence of modern soil studies on the design and construction of foundations, and it was fitting that the introductory paper should have been written by Prof. K. Terzaghi (United States). The other papers presented were drawn from the United States, Great Britain, Canada and Holland.

The proceedings of Division 2 opened with an introductory paper by Dr. T. W. Parker, deputy director of building research, Department of Scientific and Industrial Research, on general trends in research on building materials, in which reference was made to the importance of pursuing an adequate measure of fundamental research, despite the pressing demands of day-to-day technical problems, and to the need for the co-ordination of information on materials so that each may be used to the best advantage to meet the overall functional requirements of the building. The remainder of the proceedings were concerned with papers from Britain, Canada, Australia, South Africa, the United States, France, Holland and Germany, on varied aspects of research on the production, properties or utilization of the main building materials.

Four papers on the weathering and durability of building materials generally and another on the durability of concrete in engineering structures demonstrated the complexity of a subject that covered the whole range of building materials under temperate, tropical and sub-arctic conditions, and revealed much common ground of observation and experience.

Papers on burnt-clay products described developments in manufacturing processes induced in some measure by the need for economy in the use of both fuel and labour, and showed evidence of the growing recognition by the industry of the part that new fundamental knowledge of the nature of clay can play in guiding technical control of the operations. A survey was presented of the work that has been done, mainly in Great Britain, on the structural performance of burnt-clay products in respect of strength, resistance to rain penetration, fire resistance, and other functional requirements—investigations that provide a sound basis for framing codes of practice and building by-laws.

Contributions from the United States, Britain and France on the quality control of concrete on building sites showed that substantial advantages can be gained by the adoption of an organized system of control. Concrete of the quality specified in a contract can be secured with a reduced consumption of cement. Appropriate change in the conventional form of specification would provide an incentive to take economic advantage of the use of quality-control methods.

The economic and functional merits of light-weight concretes were discussed, and a review was presented on the effects of curing concrete at elevated temperature, each with comments on the directions in which there is still scope for fundamental and technical investigation.

Two papers dealt with the utilization of building stone with particular reference to means for reducing costs. One referred to the adoption of a restricted range of standard sizes of block stone in the French Standard *B*10-001 and described the construction and performance of the machines that have been developed in France for winning the stone from the quarry face and for its subsequent preparation. The other paper, based on a recent survey, set out the present differences in the cost of building houses in stone and in brick in the more important stone-producing districts of England and Scotland, and suggested ways in which the cost of building houses in stone might be reduced.

A contribution on the burning and hydration of lime described physicochemical studies that have been undertaken in South Africa with the object of explaining and eliminating building defects attributed to unsoundness in certain magnesium limes used there. Other papers dealt with the production, properties and uses of calcium sulphate plasters, with paint application, and with developments in limewash and cement paints.

The proceedings of Division 2 concluded with the presentation of three papers on timber technology. One, on the resistance to wear of timber flooring, described the development of testing equipment to reproduce qualitatively and quantitatively the wear effects observed in service; another described investigations on the use of plywood as a building material; and the third, investigations on the durability and preservation of timber.

Division 3 concerned light, heat and sound in buildings, and design research on three types of

buildings—hospitals, factories and schools. Papers had been invited from authors in Great Britain, United States, Sweden, Holland, Germany, Austria, South Africa, Australia, Switzerland and France.

In the group of papers on lighting research and its application to building problems, the four main aspects of the problem were each treated in turn. First there was a group of papers dealing with the brightness pattern of the work (meaning the particular object of attention) and its surroundings. Then came a group of papers dealing with sources of artificial light, where the difficulty is to get desired levels of lighting on the work and elsewhere without these sources sending too much light directly into the observer's eyes. The same sort of problem was stressed in the group of papers on the use of daylight, where the window is the source of light. The final group of papers was on the use of colour, by which one factor in brightness is controlled. Papers in this group on lighting made their contributions through the study of principles, of measurement and of subjective investigation, all being applied to the buildings themselves.

In heating, the range of the subject-matter discussed was wide both in methods and geography. There were papers on laboratory and analogue studies, on full-scale experiments, and on the problems presented by the range of climates from temperate to tropical. The effect of building design, and especially of thermal capacity, was found as an influence in most of the papers and discussions, especially in relation to the problems of non-steady heating. These same factors appeared also in the consideration of tropical buildings where thermal capacity is one of the main design factors by which tolerable conditions can be obtained when expensive cooling equipment cannot be used. In the session devoted to the design of heating plant, an interesting recent technique reported was the use of high-pressure hot-water systems using temperatures as high as 350° F. (176·7° C.) with consequent savings in size and cost of heating services.

The group of papers on sound were centred round the topical acoustical problems associated with auditoria and broadcasting studios. Once again, the range of matter discussed was wide, and extended from the contribution which recent theoretical developments in acoustics may be able to make to design as compared with older geometrical and statistical methods, to the consideration of the very large halls which are a feature of United States auditoria and which seat upwards of five thousand people. The particular problems of broadcasting studios were discussed in papers from Great Britain and Switzerland, as were open-air auditoria, general-purpose halls and halls designed specifically for musical purposes.

Towards the end of the Congress three sessions in Division 3 were devoted to the study of three particular types of building. One session was devoted each to hospitals, factories and schools. This application of building research is a recent development, and it is perhaps surprising to find the strict way in which experimental techniques can be, and are being, used in architectural design research. This was most strikingly demonstrated in the hospital section, where detailed observations of the use and administration of wards have led to a new thesis in planning which is now to be the subject of full-scale experiment. The schools section revealed an equally interesting innovation in the use of large-scale industrial development methods for the production of high-quality schools of various types. The section on factories was notable for the stress laid on the contribution the architect can make not only to the appearance of the building itself, but also to the detailed planning and arrangement of its interior in terms of the work to be done inside the building.

It is appropriate that the closing meetings, on September 20, should have taken place in the Royal Festival Hall, which is itself an outstanding contemporary example of the application of building research. No formal summing-up of the Congress was attempted; but at the morning session a number of members from overseas gave their impressions of the effect the Congress might have on the problems of their countries. Several of those who spoke took the opportunity of suggesting that smaller and more specialized conferences might be arranged in the future and then followed by another comprehensive congress after a period of several years. In the afternoon, Sir Ben Lockspeiser, secretary of the Department of Scientific and Industrial Research, gave an address in which he directed attention to the urgent need for the fuller application of the results of the work of men of science in this field.

LOCALIZATION OF GUSTATORY AND OLFACTORY ENZYMES IN THE RABBIT, AND THE PROBLEMS OF TASTE AND SMELL

By A. F. BARADI and Dr. G. H. BOURNE

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IT has been shown[1] that alkaline glycerophosphatase is localized in the gustatory regions of the tongue in a number of mammals (bat, rabbit and man) and in the olfactory mucosa of the rabbit. Since then, Baradi and Bourne[2] have shown that a simple esterase is present in the taste buds and epithelium of the papilla foliata of the rabbit, and that the histochemical reaction for this enzyme was inhibited by the addition of quinine to the substrate mixture and the glycerophosphatase reaction by vanillin.

In addition to these two enzymes, we have found that enzymes are present in the papilla foliata and the olfactory mucosa of the rabbit which split various substrates, such as hexose diphosphate, adenosine triphosphate, muscle adenylic acid (5-nucleotidase, Reis[3]), yeast adenylic acid (3-nucleotidase), nucleic acid (probably ribonuclease), long-chain fatty acids (lipase), alpha-glycerophosphate at *p*H 3–5 (acid phosphatase). The distribution of these enzymes in the papilla foliata is shown in Fig. 1. In general, one can say that all the enzymes are located in the epithelium lining the folds between the papillæ, although some are present in addition in the neighbouring epithelium. Acid phosphatase is present in only small amounts at the bases of the papillæ; ribonuclease is present only in the epithelium immediately overlying the taste buds; esterase and acid phosphatase are present in taste buds and in Ebner's glands; and the enzymes which split yeast and muscle adenylic acid appear to be present in all nuclei in the preparations, as well as in the cytoplasm of superficial epithelial cells.

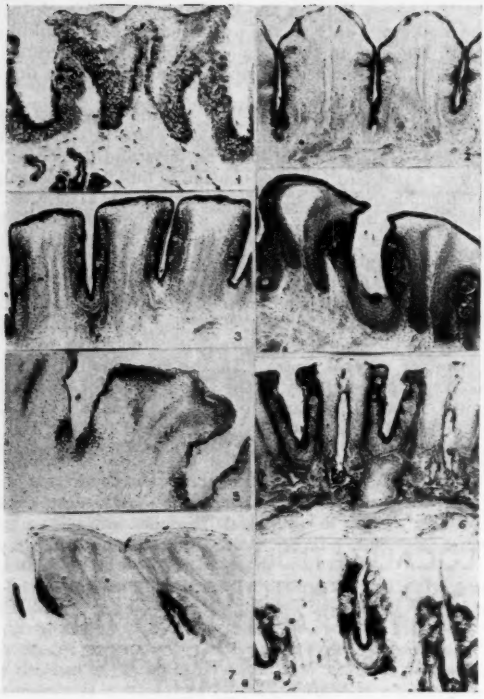

Fig. 1. Preparations of the papilla foliata of the rabbit
(1) Esterase present in the basal epithelial cells, the taste-bud cells and the acini of Ebner's glands.
(2) Hexose diphosphatase. High concentration in the epithelium of the folds between the papilla and a slight concentration in the epithelium on top of the papilla.
(3) Yeast adenylase (3-nucleotidase). Superficial layers of the epithelium appear to contain the enzyme in large amounts. The enzyme is also present in the taste buds.
(4) Acid phosphatase. Present in all epithelia and in Ebner's glands. Highest concentration in superficial layers of epithelium and in taste buds.
(5) Lipase. In superficial epithelial cells of papilla and in a cluster of cells near the base of the crypts.
(6) Muscle adenylase (5-nucleotidase). Present in superficial epithelium of papillæ and in taste buds. Present in nearly all nuclei in this region.
(7) Nuclease (probably ribonuclease). Present only in epithelium immediately on top of taste buds.
(8) Effect of adding quinine to ribonuclease substrate mixture in which slide was incubated. All epithelium between papillæ shows high concentration. Enzyme also now present in taste-bud cells.

The distribution of enzymes in the nasal mucosa is shown in Fig. 2. All the phosphate-splitting enzymes are concentrated entirely in three or four basal cells in the olfactory epithelium. As centres of enzyme activity these cells appear comparable with the stratified epithelial cells which line the folds in the papilla foliata. The ducts of Bowman's glands are positive for alkaline glycerophosphatase but the glands are negative. However, they are positive for lipase and esterase. Lipase is only present in this site; but esterase is present in all the cells of the olfactory epithelium as well.

The localization of these enzymes in and around the gustatory and olfactory organs in the rabbit suggests that they may be associated in some way with the mechanism of smell and taste.

It has been suggested by Kistiakovsky[4] that the mechanism of smell could be explained by the existence in the olfactory mucosa of four enzyme groups (one for each of the theoretical basic smells), and that odoriferous substances are distinguished by their differential inhibition of particular enzyme groups. The same explanation might be used to account for a mechanism capable of distinguishing between substances of different taste.

At the time Kistiakovsky's suggestion appeared, we had already tried out the *in vitro* effect on the gustatory enzymes of a number of substances with a well-defined taste. These had been added to the substrate solutions used for localizing the enzymes. Complete details will be published elsewhere, but we refer here to a few of the more outstanding results. Vanillin (0·05 per cent) inhibited glycerophosphatase activity but had no effect on any other reactions. Tea infusion inhibited esterase and ribonuclease reactions. Sucrose had no effect and saccharine inhibited esterase. Quinine inhibited the glycerophosphatase, the 5-nucleotidase and the esterase reactions and greatly *increased* the ribonuclease reaction. Some inhibition of the ribonuclease, 5-nucleotidase and 3-nucleotidase (yeast adenylic acid) reaction was obtained by adding enough sodium chloride to the substrate mixture to bring its concentration to twice that of normal saline. Capsicum, aniseed, peppermint and coffee also caused differential inhibition of the various enzyme reactions.

The accentuation of the ribonuclease reaction by quinine suggests that the enzyme was in these sites

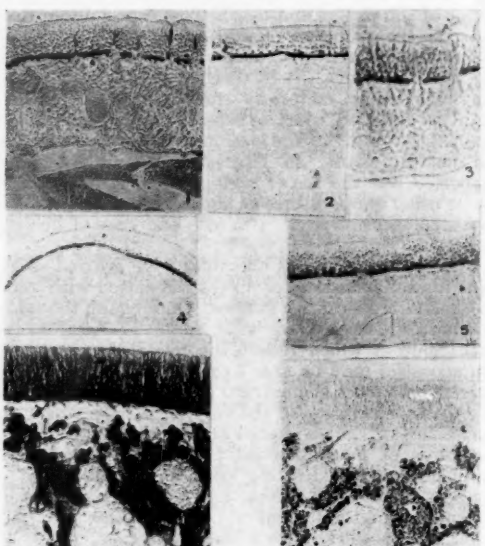

Fig. 2. Preparations of the olfactory mucosa of the rabbit
(1) Glycerophosphatase. In most basal layers of cells of epithelium. Underlying Bowman's glands and nerve fasciculi negative. Ducts of Bowman's glands give a strong positive reaction.
(2) Hexose diphosphatase. In most basal cells of epithelium only.
(3) Adenosine triphosphatase. Present only in most basal cells of epithelium.
(4) 5-Nucleotidase. Principally in most basal layer of epithelial cells. All nuclei are positive. The enzyme also present on surface of epithelium.
(5) 3-Nucleotidase. Principally in basal layer of cells of epithelium. More superficial cells of basal cells also positive.
(6) Esterase. All basal cells of epithelium intensely positive. Olfactory cells also positive. Bowman's glands intensely positive. Nerve fasciculi negative.
(7) Lipase. Only Bowman's glands positive.

before, but at too low a concentration to give a positive result. The amount of quinine used (0·5 per cent) would have been sufficient to combine with all the substrate present and may have facilitated its splitting by low concentrations of the enzyme. It seems probable that all these substances may exert their effect by combining with the substrate. The possibility of some interference with a co-enzyme must, however, also be considered. It is also of interest that the *dl*-isomer of tryptophane, which is sweet, inhibits the glycerophosphatase reaction, and the *l*-isomer, which is bitter, has only a slight inhibitory effect.

A number of technical criticisms may be made of this work, and if they were correct they may to some extent invalidate it. These are: (1) Is there a non-specific attraction by the apparent sites of enzyme activity for some of the reaction products (for example, calcium phosphate)? (2) The enzyme may be present in a particular site and give no reaction[5]; this is supported by the way quinine causes a positive ribonuclease reaction in otherwise negative sites. (3) Are we demonstrating one phosphate-splitting enzyme or a number of such enzymes? (4) Are the inhibitions of activity true interference with enzyme substrate reaction, or do they simply represent interference with the histochemical reaction, for example, prevention of deposition of reaction product?

If (1) were correct, all phosphate-splitting enzymes would have an identical distribution. They do not. Also, at the suggestion of Prof. J. Danielli, calcium phosphate was precipitated by adding hydrogen peroxide to the incubating medium over a section in which enzyme activity had been destroyed. There was no particular affinity on the part of the sites of enzyme activity for the calcium phosphate. The second criticism may be correct, but we claim only that positive results indicate the presence of enzyme and we do not deny that it may be present in apparently negative sites. In fact, our results indicate that it may be present in such sites. In the case of (3), it may be that glycerophosphatase, a known non-specific enzyme, may contribute to some extent to the results obtained with other substrates; but different distribution, together with differential inhibition (apart from other independent evidence), strongly suggest that we are dealing with a series of different, though probably closely related, enzymes. If the inhibitions represent only interference with the histochemical test (4), then, for example, any substance which inhibits one phosphate-splitting enzyme will inhibit them all. This is not the case, and, in fact, one inhibitory substance (quinine) actually accelerates the action of another phosphate-splitting enzyme. Further discussion of this problem will be given in subsequent publications, but at the moment we believe that these inhibitions represent true interference with enzyme substrate reaction, even allowing for the well-known variability of histochemical preparations.

If we assume, therefore, in the absence so far of any contradictory evidence, that these enzymes are localized in the sites described, and that their action is inhibited or accelerated by various substances with pronounced taste, we are impelled to ask in what way such a mechanism could explain any of the phenomena of taste.

Generally speaking, the enzymes we have studied are localized in six main sites. Furthermore, there is an abundant nerve supply[6,7] to the epithelium of the papillæ as well as to the taste buds.

Taking these facts into consideration, we suggest the following tentative hypothesis to explain their relation to the mechanism of taste. The chemical reaction involved in the breakdown of substrate by enzyme presumably gives rise to ionic changes which would induce currents in nearby nerve fibres. We can then conceive of a tasting substance coming into contact with superficial enzyme sites. It would inhibit the activity of an enzyme in one site, accelerate the activity of an enzyme in another site and have no effect on enzymes in other sites and so on. It would therefore alter the pattern of nerve impulses reaching the brain, and each substance would produce its own individual pattern. Since there are six main sites of enzyme activity, each of which can be accelerated, inhibited or left unaffected, we have a mechanism for distinguishing between 2,160 tasting substances. This hypothesis therefore makes the conception of four basic tastes unnecessary. It also suggests that the taste buds are not the sole organs of taste, but that they are only reference or focusing points to which the brain can relate impulses coming from other sites; in other words, they give precision to taste.

This hypothesis also serves to explain why substances of widely differing chemical nature can have a similar taste. The distribution of the enzymes overlaps at the various sites; therefore inhibition of *different* enzymes at the *same* sites by *different* substances will produce the same pattern of nerve impulses, which will be interpreted by the brain as the same taste.

The same hypothesis can probably be used to explain the sense of smell. Most of the gustatory enzymes have also been found in the olfactory mucosa (and are inhibited in the same way). Here again we feel that the sense of smell may not be the sole property of the so-called olfactory cells but that these cells may act only as reference points with relation to the rest of the olfactory mucosa and that, in fact, they may function in the same way as the taste buds in the tongue.

There are almost certainly very many more enzymes in the gustatory and olfactory regions, but we are limited in this work to those which can be localized histochemically. There are still some, for which histochemical tests exist, which we have not yet tried. Nor have we yet taken into account the significance of the distribution of certain enzymes in Ebner's and Bowman's glands.

This conception of taste and smell can, of course, be only of a provisional nature and it may, in the light of future work, be subject to substantial alteration. Nevertheless, we find it useful at the present moment as a working hypothesis.

The phosphate-splitting enzymes were demonstrated by the technique described by Gomori[8], the lipase also by a Gomori method[9] and the simple esterase by Gomori's unpublished modification of the Nachlas–Seligman method[10].

We are indebted to W. J. Bush and Co., Ltd., for a supply of essential oils and essences used in this work.

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ANNIVERSARY OF TRANS-ATLANTIC RADIO

By Dr. R. L. SMITH-ROSE

On December 12, Marconi's Wireless Telegraph Co., Ltd., is celebrating the fiftieth anniversary of the first demonstration that electromagnetic waves could be transmitted across the Atlantic Ocean, over a distance of 2,200 miles. Following Marconi's early experiments in Great Britain, wireless telegraphy was developing very rapidly at the turn of the century for short-distance communication; particularly between ships and shore. Early in 1900, Marconi applied for a British patent describing appliances for conducting what was termed 'syntonic telegraphy', in which for the first time provision was made for adjusting the transmitting and receiving apparatus to operate on the same frequency or wave-length. The investigations on what we now understand as 'tuning' the equipment were essential steps in the development of long-distance trans-oceanic wireless telegraphy; and a year later, in January 1901, communication was established between St. Catherine's, Isle of Wight, and the Lizard, Cornwall, a distance of two hundred miles. Prior to this achievement, however, Marconi had already decided to make a serious attempt to send electric waves across the Atlantic; and he had enlisted the services of John Ambrose Fleming to assist in the design and installation of a high-power spark transmitting station at Poldhu in Cornwall. The project was not without its difficulties; and, viewed from the vantage point of fifty years later, the detailed technical history is of some interest and will be found recorded in Fleming's book on "The Principles of Electric Wave Telegraphy and Telephony", the first and second editions of which were published in 1906 and 1910, respectively. Reference may also be made to a "Handbook on Radio Communication", published by the Science Museum (see *Nature*, 135, 326; 1935), and to the fact that this Museum has in its collections some of the items used in these experiments.

Fleming was responsible for specifying the electrical engineering plant to be used (having an output of 25 kW.) and for designing special portions of the apparatus for generating and controlling the, for that time, powerful radiation of electric waves it was desired to create and use. At the same time, Marconi decided on the nature of the aerial system to be erected, which originally comprised a ring of twenty masts, 200 ft. high, arranged in a circle of 200 ft. in diameter, and supporting aerial wires grouped in the form of an inverted cone.

In the early months of 1901, experiments began with the view of completing the arrangements, and numerous telegraphic tests were carried out between Poldhu and Crookhaven in the south of Ireland, and Niton in the Isle of Wight. There were various setbacks, not least of which was the wrecking of the aerial system at Poldhu by a storm on September 18, 1901. The Marconi Company, however, quickly erected two wooden masts 160 ft. high and 200 ft. apart and carrying a fan-shaped aerial of 50 wires. Within two months, sufficient progress had been made to enable Marconi to contemplate making an experiment across the Atlantic; and he left England on November 27, with his two assistants, G. S. Kemp and P. W. Paget, arriving at St. Johns, Newfoundland, on December 5.

Here again, there were difficulties associated with rough weather. The receiving station was located in a government building at Signal Hill, Newfoundland, and the aerial was supported in the first place by a balloon. This was, however, lost on its first ascent, and was replaced by a large kite carrying an aerial wire which was successfully flown to a height of 400 ft. The rise and fall of the kite in the wind caused variations in the capacity of the aerial, and this precluded the use of any of the syntonic receiving apparatus which was then available. The apparatus actually used was simply a self-restoring coherer in series with the aerial and a telephone earpiece.

By prior arrangement, confirmed by cable, a daily programme of transmissions which consisted in sending the letter *s* (three successive dots in the Morse code) began on Wednesday, December 11. These signals were received and recognized on the following day, December 12, at 12.30, 1.10 and 2.20 p.m., and again at 1.38 p.m. on Friday, December 13. In this way, the fact was established that, contrary to the expectations and predictions of some theoretical workers, these electromagnetic waves could be transmitted and successfully detected around a considerable fraction of the curved surface of the earth.

The achievement created an immense sensation in every part of the civilized world, although, of course, there was much to be learned concerning the laws of propagation of radio waves and the influence of the ionosphere as we know it to-day, before communication sufficiently reliable for the transmission of coherent messages could be attained. This accomplishment was the starting point of the past fifty years of development leading to the vast and complex network of communications, broadcasting and navigation services in use to-day.

In December 1902, the Poldhu station began the first trans-Atlantic wireless telegraph service; and with various modifications from time to time this service continued until June 10, 1922, when Poldhu was finally closed for public transmissions. After that the station was used by C. S. Franklin in his experimental work with Marconi on directional short-wave transmission. Poldhu was dismantled in 1933; to-day a memorial column of granite marks the site, and inscriptions on three of the four plaques on its sides summarize the achievements described above. The fourth plaque records that "The site of this column and some six acres of land on the edge of these cliffs together with the cliffs and the foreshore beneath them were given to the National Trust in 1937 by the Marconi Company to commemorate the pioneer work done at the Poldhu wireless station between 1900 and 1933 by its research experts and radio engineers".

In concluding this article, reference may be made to another milestone in the development of radio communication across the Atlantic. This occurred twenty years later almost to the day, when, on December 9, 1921, signals were successfully received in Great Britain from twenty-seven amateur transmitting stations in America operating on wave-lengths between 200 m. and 375 m., some using spark and some continuous-wave equipment. These wave-lengths may be compared with that of about 1,800 m. used at Poldhu, and may be regarded as an intermediate step in the development of the short waves (10–100 m.) which are now used for the bulk of the world's long-distance radio-communication and broadcasting services.

OBITUARIES

Mr. William E. Heath

THE sudden death on October 25 of Mr. William E. Heath, reader in agricultural economics and vice-dean of the Faculty of Agriculture and Horticulture of the University of Nottingham, was a heavy loss to agricultural economists in the United Kingdom. Although only forty-five years of age, he was recognized as one of the leading members of his profession.

As head (until 1947) of the Farm Economics Branch of the Department of Agriculture for Scotland, one of his main tasks was the direction of a pioneer study of the problems of marginal agricultural production. At Nottingham, his main preoccupation was the extension of the teaching and research of his Department and the development of standard measures of economic efficiency capable of application by advisory officers and by farmers. Agricultural economists should, in his view, supply the farming community with yardsticks and guide posts which would enable better use to be made of farm resources and assist advisory officers to understand the economic implications of the technical advice they give to farmers. It was also his ambition to build up a good library of agricultural economics literature, and he had recently completed exchange arrangements with every institution in the English-speaking world with an agricultural economics department.

Heath was particularly interested in problems of agricultural policy and of the most efficient utilization of those national resources devoted to agricultural production. He was regarded as one of the best informed and most inspired workers in this important field. He had recently returned from a six months visit to the United States, and as he was a member of the Council of the International Conference of Agricultural Economists his loss will be felt by many outside Great Britain.

Although lamed in youth by an attack of infantile paralysis, he bore his affliction with a courage which compelled the admiration of all who came into contact with him. He took a particular interest in the work of local young farmers' clubs, but he will perhaps be best remembered by many of his younger colleagues for the sound guidance and genuine encouragement he gave them at the start of their careers.

R. BENNETT JONES

Mr. P. A. Curry

PHILIP ARTHUR CURRY, lately deputy director-general of the Physical Department of the Ministry of Public Works, Egypt, died suddenly at Littlehampton at the age of sixty-seven. After his education at Darlington Grammar School and Trinity College, Cambridge, he joined the Egyptian Survey in 1905. During the First World War he served with the Survey Company in Egypt and Palestine and afterwards became deputy director-general of the Physical Department of the Ministry of Public Works, Egypt, from which he retired in 1939. Concurrently with this he was, first, director of the Weights and Measures Service which he started and organized, and afterwards director of Helwan Observatory. He was an excellent administrator, a very good observer and skilful with instruments. Among a large amount of very useful work were the first determinations of gravity in Egypt and the Sudan, the results of which and other work are recorded in scientific papers. He was a good friend and valued colleague, and his death will be regretted by many, both Egyptian and British. He leaves a widow, two sons and two daughters.

H. E. HURST

NEWS and VIEWS

Zoology at Birmingham: Prof. O. E. Lowenstein

DR. O. E. LOWENSTEIN, whose appointment as Mason professor of zoology in the University of Birmingham in succession to Prof. P. B. Medawar has recently been announced, was born and educated in Munich. He became assistant to Prof. von Frisch; but when the Nazi party came to power he left Germany in 1933. Through the good offices of the Academic Assistance Council and of Prof. H. Munro Fox, he was able to resume research in the University of Birmingham, where he remained, taking the degree of Ph.D., until 1937, when he went as assistant lecturer to Exeter. In the following year he moved to Glasgow, becoming eventually senior lecturer in zoology. He combines to an unusual degree the technical skill and intense research interests of the specialist with the broad knowledge of the teacher. A most distinguished worker in electrophysiology, he has made notable use of the oscillograph to investigate the function of the vertebrate labyrinth. Initial studies, largely in collaboration with the late Dr. A. Sand, on the semi-circular canals in fishes, have been followed by analysis of the gravity and vibration responses of the more delicate otolith organs. He is responsible for major advances in knowledge of the distribution of functions within this most complex receptor. The width of Dr. Lowenstein's interests are revealed by his complete revision of the volume on invertebrates in Parker and Haswell's "Text-book of Zoology". No one has lectured more widely on zoological topics to university students, and he has given courses on biology and human affairs to arts students and to adult education classes. He is equally happy as research worker and as teacher, and in both capacities he will find full scope for his great abilities in the further development of the Department of Zoology at Birmingham.

Melvil Dewey (1851–1931)

SCIENTIFIC libraries throughout the world to-day use the Dewey decimal system of classification or one of its modifications. Its originator, Melvil Dewey, was born at Adams Center, New York, a century ago, on December 10, 1851. In his youth he already displayed an enthusiasm for classification and systematization. At the age of twenty-three he graduated at Amherst College, where as acting librarian he first proposed his decimal system of classification for cataloguing and arranging books and pamphlets in a library. In 1876 he helped to found the American Library Association, serving as its secretary from 1876 until 1890 and as editor of *The Library Journal* during 1876–80. Appointed librarian of Columbia

College in 1833, he established the School of Library Economy, the first institution in the United States for the training of librarians. His welcoming of women pupils met with much disapproval, as did his questionnaire concerning their height, weight, and colour of hair and eyes, and his request for a photograph. From 1889 until 1906 he was director of the New York State Library, and he inaugurated a system of travelling libraries and picture collections. A man of boundless enthusiasm and energy, Dewey promoted the use of the metric system and was keenly interested in spelling reform. In his long and useful life this great library pioneer succeeded in making many friends and also many enemies. He died in Florida on December 26, 1931.

The Coal Industry of Great Britain

The study of the coal industry carried out by the Acton Society Trust and published under the title "The Extent of Centralization" merits the attention of a wider field than those directly connected with the industry, for it may be said that the economy of Great Britain as a whole hinges upon coal, the most important of its natural resources. Apart from the discussion of the position of the technical specialists and the use made of them—a problem which is particularly acute in the coal industry, for reasons indicated in this study, and which is the main source of complaints of over-centralization made by men within the coal industry—the report is important as providing strong evidence against the desirability of rapid and sweeping changes by legislation or otherwise. It points out that improvements are most likely to be achieved gradually; the problems are essentially those of human relations, and what is required appears to be a series of small practical improvements which in the aggregate will eventually change the whole atmosphere of the industry. The inquiry gives a clear picture of the organization of the industry and of the system of technical and functional control in use. It indicates the impossibility of carrying out a large programme of re-equipment and redevelopment on a national scale with the fullest economy without some interference with the free judgment and initiative of local government. Arrangements for achieving these ends are largely responsible for the sense of frustration which exists at several levels of the industry and for many complaints of over-centralization. Some research may well be required in order that all such problems may be solved; and the difficult one of the status of the colliery manager, the wider implications of which are discussed elsewhere, will only be fully solved when by a process of education a more highly trained type of manager, alert enough to seek and use the best technical advice available, is readily obtainable.

Antiquity of the Australian Aborigines

At the Brisbane meeting of the Australian and New Zealand Association for the Advancement of Science, Mr. Edmund D. Gill, palæontologist in the National Museum of Victoria, gave an address on new evidence for the antiquity of man in Australia. He pointed out that Sir Richard Owen described the extinct marsupial *Thylacoleo* from bones collected by an early settler, William Adeney, from the shore of Lake Colongulac (=Timboon), Western Victoria, beside which he lived. For more than a century this has been the classic locality in Victoria for extinct giant marsupials, *Diprotodon*, *Procoptodon*, etc., being also described from here by Owen, McCoy and others. However, it has not been known previously from what bed these fossils came, but recently this was discovered and fossils collected therefrom. A dingo jaw and a carved bone (the Colongulac Bone of earlier authors), evidences of human occupation, were also collected by Adeney, and are in the National Museum, Melbourne. The fossils from this bed are remanié, being derived from a still earlier bed. An unusual matrix and the type of preservation made it easy to recognize that the collections in the Museum from Lake Colongulac came from this horizon. Since the extinct marsupial fossils were embedded, the local volcanoes have laid down an ash-spread, and a lake has cut back the resultant tuff for a great distance so as to form cliffs in it. After that came a comparatively arid period when the lake dried up, and dunes of loess more than 50 ft. high were built from the desiccated lake floor. In this loess a fossil aborigine was found. Since the dune-building phase, there has been a pluvial period when the lake returned, cutting cliffs 25–30 ft. high in the loess; also a high-level alluvium (now incised) was deposited in the valleys of creeks entering Lake Colongulac (consequent type). The loess is considered to belong to the Mid-Holocene Arid Period and the tuff to early Holocene. The cycles of sedimentation and erosion affecting the fossil bones thus carry back into the Pleistocene. Hence there is evidence for Late Pleistocene and Middle Holocene human occupation of this area.

British Bulletin of Spectroscopy

A new venture in the literature of spectroscopy started this September with the first number of the *British Bulletin of Spectroscopy*. It is in the form of a four-page news sheet with notices of forthcoming events, reports of various meetings in Britain and overseas, and notes and comments on recent publications and on new experimental techniques, including a summary of recent progress on applied spectroscopy at the British Iron and Steel Research Association. The *Bulletin* is in two sections: emission spectroscopy, edited by K. Dixon and W. Ramsden; and molecular spectroscopy, edited by G. H. Beavan and W. C. Price. It has been published with the co-operation of the Industrial Spectroscopy Group of the Institute of Physics, the Photoelectric Spectroscopy Group, the Infra-Red Discussion Group and the Physical Methods Group of the Society of Public Analysts and Other Analytical Chemists. It is hoped that the *Bulletin* will mark a step towards closer co-ordination of the several spectroscopic groups in Great Britain. In the foreword, by S. D. Steele, the need is stressed for some publication to cover the many small developments in experimental technique which often fail to find their way into the major scientific journals. It is also hoped that the *Bulletin* may become a useful medium for expressing views by correspondence, which will be welcomed. It is published independently and is available to all interested at 5*s*. a year, post free, from the honorary treasurer, W. H. Storey, Unicam Instruments (Cambridge), Ltd., Arbury Road, Cambridge.

The Fair Isle Bird Observatory

The second annual report of the Fair Isle Bird Observatory Trust is, like the first, a record of sound work well done. During 1950 active field-work was carried out for a period of twenty-eight weeks, the

work of trapping and bird-ringing being continued by the Warden during the rest of the year. Among the field-workers were students from schools and universities, some of these making a return visit to continue observations begun in the previous year. In addition to migration news, the report contains sections on selected species, trapping and bird-ringing and ecto-parasites. There is also an interesting account of the recorded breeding habits of the arctic skua, great skua, grey wagtail, lapwing and fulmar. Among other items in the report are some notes in field taxonomy, special studies of the wheatear and redwing, and a statistical account of wheatear weights. The report may be obtained from the Honorary Secretary of the Trust, 35 George Street, Edinburgh 2.

Imperial Forestry Institute, Oxford : Annual Report for 1949–50

THE twenty-sixth annual report of the Imperial Forestry Institute covers the year 1949–50 (pp. 27 ; Oxford : the Institute, 1951). The number of students attending the Institute during the year was fifty-nine, thirty-nine being undergraduates. The record number of thirty took the final honours 'school', three obtaining first-class, seven second-class, fourteen third-class and four fourth-class honours. A new departure was initiated in the previous year of sending selected subordinate service officers from the Colonies for a special course, the satisfactory completion of which may lead to promotion. This scheme has been continued, two Nigerian forest assistants and one European forester from Uganda going to Oxford. They completed the courses creditably, and the step taken is undoubtedly a wise one, since the best forest-workers below the officer grade should, if afforded the opportunity, make efficient gazetted officers. One of the successful candidates in the above-mentioned Oxford honours 'school' was a member of the Malayan subordinate forest service, and will be the first Malayan to obtain a forestry degree and promotion to the higher service. The report is full of information ; details of the Institute, the practical courses and the research work undertaken by the staff are given. It has one disadvantage : it is difficult to distinguish between Oxford undergraduates taking forestry and the officers from the Colonies taking refresher courses and so forth, particularly as regards the respective courses they are following and especially the practical courses.

Glossary of Terms used in the British Plastics Industry

A RECENT pamphlet, "Glossary of Terms used in the Plastics Industry" (British Standard 1755 : 1951. Pp. 59 ; London : British Standards Institution, 1951 ; 6s. net.), was compiled by the British Plastics Federation and is one of the documents being prepared by the British Standards Institution to cover glossaries of terms used in various industries. It is hoped that the Standard will be of considerable use to members of the plastics industry and will serve as a basis for discussions on an international glossary for plastic materials. The terms are grouped in sections to cover : chemistry ; industrial applications ; constituents ; properties, including thermal, electrical and mechanical ; moulding processes and other manufacturing processes such as casting, extrusion, welding and finishing. The terms listed in the sections are fully defined. An alphabetical index is a useful addition.

"Elastic Constants of Alkali Halide Crystals"

THE following note added in proof to the communication by Sir K. S. Krishnan and Dr. S. K. Roy published in *Nature* of November 17, p. 869, was received too late for incorporation :

The corresponding table for the elastic constants of cæsium chloride, expressed in terms of $e^2/(16d^4)$, where d is the Cs–Cl distance in the crystal, is :

	11	12	44
s	$6\alpha' - 18\chi'$	$-15\alpha' + 9\chi'$	$-3\alpha' + 9\chi'$
ρ	$2\alpha'(\delta - 2)$	$2\alpha'(\delta + 4)$	$2\alpha'(\delta - 2)$
c	$2\alpha'(\delta + 1) - 18\chi'$	$\alpha'(2\delta - 7) + 9\chi'$	$\alpha'(2\delta - 7) + 9\chi'$

α' and χ' are defined in the same manner as α and χ respectively, except that ξ, η, ζ do not now take all integral values, but are restricted to where they are all three odd, and all three even ; $\alpha' = 1{\cdot}018$ and $\chi' = -1{\cdot}08$.

Colonial Service : Recent Appointments

THE following appointments have recently been made in the Colonial Service : C. W. Lynn (senior agricultural officer, Gold Coast), assistant director of agriculture, Gold Coast ; A. Jackson (senior chemist, Federation of Malaya), chief chemist, Federation of Malaya ; R. J. Dewar (assistant conservator of forests, Nigeria), assistant conservator of forests, Nyasaland ; S. A. Child (dairy and poultry officer, Northern Rhodesia), livestock officer, Tanganyika ; St. G. C. Cooper (agricultural superintendent, British Guiana), agricultural superintendent, Dominica, Windward Islands ; D. J. Bettson, agricultural officer, Gold Coast ; L. A. Heapy, agricultural officer, Nigeria ; J. L. B. Hitchcock, probationer in agriculture, Federation of Malaya ; T. E. T. Trought, entomologist, Uganda ; T. G. Allan, assistant conservator of forests, Fiji ; F. S. Wilson, assistant conservator of forests, Tanganyika ; J. L. M. Lambert, geologist (petrologist), Tanganyika ; J. Robinson, senior scientific officer (chemist), Colonial Insecticides Research Unit, Tanganyika ; Miss K. F. Salmond scientific officer (entomologist), Bulk Stored Grain Infestation Research, Nyasaland ; W. A. Sands, scientific officer, Termite Research Unit, East Africa High Commission ; B. Steele, scientific officer (botanist), Tsetse Fly Survey, Nyasaland ; B. R. Thompson, veterinary officer, Northern Rhodesia ; D. C. P. Evans, agricultural officer, Gold Coast ; W. P. Jaffe, livestock officer, Veterinary Department, Tanganyika ; M. Z. Snihur, meteorological officer, Northern Rhodesia ; D. Stephens, specialist in chemistry, Agricultural Department, Gold Coast ; K. A. Watson, agricultural superintendent, Nigeria.

Ramsay Memorial Fellowships for Chemical Research

THE Ramsay Memorial fellowships for chemical research for 1951–52 have been awarded as follows : L. E. Lyons, a British fellowship of £500 a year at University College, London ; James Jack, a Glasgow fellowship of £500 at the University of Cambridge ; Dr. K. O. G. Kutscke, a Canadian fellowship at the University of Leeds ; Dr. Serafin Novoa, a Spanish fellowship at the Agricultural Department, University of Oxford ; Dr. Garcia de la Banda, a Spanish fellowship at the University of Bristol ; Dr. Margaret D. Cameron, a United States fellowship at the University of Leeds. These awards involve the re-establishment, with the co-operation of the Fulbright

Commission, of the United States fellowship which has been in abeyance since 1928; they also include a second Spanish Ramsay fellowship. In addition, the British Ramsay fellowship, held by Dr. E. Gelles, has been renewed for a further year, and an extension of four months has been granted to H. Mendel (Netherlands) at the University of Oxford.

The Nature Conservancy: Awards for 1951

The Nature Conservancy has announced the following awards of research studentships for post-graduate training in ecology, tenable for periods of up to three years at the universities named. *Botany:* Miss B. Blanchard (Liverpool); D. H. Dalby, Miss J. M. Laptain (University College, London); M. C. F. Proctor (Queens' College, Cambridge); R. G. West (Clare College, Cambridge); D. A. Robertson (King's College, Newcastle upon Tyne). *Palæontology:* R. E. H. Reid (University College, London). *Zoology:* R. D. Hughes (Imperial College of Science and Technology, London); J. D. Lockie (Balliol College, Oxford); A. W. G. Manning (Merton College, Oxford); D. J. Morris (Magdalen College, Oxford); H. Roberts (University College, Southampton); I. W. B. Thornton (Leeds).

Christmas Lectures for Juveniles (London)

A number of lectures for juvenile audiences, to be held in London during the Christmas holidays, are being arranged by various organizations. At the Royal Institution (21 Albemarle Street, W.1), the Christmas Lectures "to a juvenile auditory" will be given by Prof. James Gray on "How Animals Move" at 3 p.m. on December 27 and 29, 1951, and January 1, 3, 5 and 8, 1952; the fee for these lectures is: juveniles £1, adults £2. The Institution of Civil Engineers (Great George Street, S.W.1) is holding three lectures, for boys 13–17 years of age, on "Exploring for Oil", "Transporting Oil in Peace and War (Pluto)", and "Working of an Oil Refinery", to be given at 3 p.m. on December 28 and 31, 1951, and January 2, 1952 respectively. The Royal Geographical Society (1 Kensington Gore, S.W.7) is arranging a lecture, "Jumbos and Jungles", and a sound film, "Scott's Last Expedition", to be given at 2.30 p.m. on December 28 and 31, respectively, for which application should be made before December 14. At the Institution of Electrical Engineers (Savoy Place, W.C.2) the sixth Christmas lecture of the Institution will be given twice, at 3 p.m. on January 3 and 4, 1952, the subject being "Electricity in Civil Aviation". The Royal Photographic Society (16 Princes Gate, S.W.7) is holding three lectures at 3 p.m. on December 31, 1951, and January 1 and 2, 1952, on "How a Lens Forms an Image", "Three-Dimensional Films", and "The Miracle of the Photographic Emulsion", respectively. In addition, the London County Council is holding twelve lectures on various subjects which will be given in different parts of London between December 31, 1951, and January 4, 1952; applications should be made through the pupil's school.

Scientific Advisers for Civil Defence

The Home Secretary has announced that the following men of science have been appointed, in a voluntary capacity, to advise on civil defence in the regions indicated: *South Western Region (Bristol):* senior scientific adviser, Prof. W. E. Garner; scientific advisers, Prof. S. H. Piper and Prof. F. H. Newman. *Midland Region (Birmingham):* senior scientific adviser, Prof. H. W. Melville; scientific advisers, Prof. P. B. Moon and Prof. J. R. Squire. *London Region:* senior scientific adviser, Sir Charles Ellis; scientific advisers, Prof. W. V. Mayneord and Dr. H. N. Rydon. *North Midland Region (Nottingham):* senior scientific adviser, Prof. L. F. Bates; scientific advisers, Prof. L. Hunter and Dr. D. O. Jordan. *Northern Region (Newcastle upon Tyne):* senior scientific adviser, Prof. W. E. Curtis; scientific adviser, Prof. G. R. Clemo. *North Eastern Region (Leeds):* senior scientific adviser, Prof. F. W. Spiers; scientific advisers, Prof. W. Bradley and Prof. W. Sucksmith.

Announcements

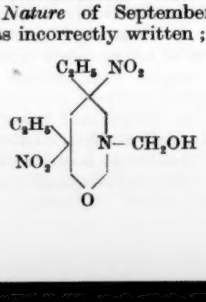
Sir David Brunt, professor of meteorology in the Imperial College of Science and Technology, University of London, has been appointed to the Board of Directors of the Fulmer Research Institute, Stoke Poges, Bucks. The Institute was founded in 1946 on the initiative of Colonel W. C. Devereux, chairman, and opened officially by Sir Stafford Cripps, then President of the Board of Trade, to carry out sponsored research, the results arising therefrom (including patents) belonging solely to the sponsors.

Dr. D. J. E. Ingram, of New College, Oxford, has been appointed research fellow in the Department of Electronics, University College, Southampton, with effect from January 1, 1952. He will be mainly concerned with the work on microwave spectroscopy which is being carried out at the College.

The conference this year of the Universities of Great Britain and Northern Ireland, convened by the Committee of Vice-Chancellors and Principals, will be held in the William Beveridge Hall, University Senate House, London, W.C.2, during December 14–15. There will be three sessions, as follows: "The Procedure for the Selection of Students for Admission to the Universities", "Universities and the Fine Arts" and "Student Health". The conference is only open to delegations appointed by the universities and to specially invited guests. Further details can be obtained from the secretary, Dr. J. F. Foster, at 5 Gordon Square, London, W.C.1.

An account is given on p. 975 in this issue of the Building Research Congress, 1951, which took place in London during September 11–20. The papers presented at the Congress have been printed in three paper-covered books, one dealing with each Division of the Congress. Copies of these books are now available, price 22*s.* 6*d.* each, or 50*s.* for the set of three, from the Organizing Secretary, Building Research Congress, 1951, Building Research Station, Garston, Watford, Herts. The price is reduced in the case of members of bodies which participated in the Congress.

Erratum. In the communication by Prof. T. Urbański entitled "New Derivatives of Nitroparaffins and Antitubercular and Antirickettsial Properties" in *Nature* of September 29, p. 562, formula (III) was incorrectly written; it should be:



DEGRADATION OF DEOXYRIBONUCLEIC ACID BY A 'NITROGEN MUSTARD'

By Dr. J. A. V. BUTLER, L. GILBERT, D. W. F. JAMES and W. C. J. ROSS
Chester Beatty Research Institute, Royal Cancer Hospital, London

IT has been shown[1] that, when treated with certain compounds of the 'mustard' type, deoxyribonucleic acid is degraded, the molecular weight as determined by measurements of sedimentation and diffusion falling from an apparent value of *c.* 10^6 to values between 10^4 and 10^5. The significance of this has been doubtful owing to uncertainty as to the structure of the nucleic acid and whether the molecular weight represents an aggregate or a single polymeric molecule. If the former, the low values obtained after the treatment might be due to its dissociation into the component units, when modified by the reaction. This possibility was supported by observations given in a previous communication[2]. However, new facts have been observed which are difficult to account for on this hypothesis, and support fairly directly the idea that the degradation is due in part to the breakage during reaction of the polymeric nucleic acid chain into smaller units.

The values determined of the molecular weight of the degraded nucleic acid have varied very widely, and in experiments made to ascertain the causes of the variation we made measurements of the sedimentation constant at intervals during the reaction with $CH_3—N(CH_2.CH_2.Cl)_2$ (I) and afterwards. It was found that when the reaction medium was $N/10$ sodium bicarbonate (*p*H 8·6) the sedimentation constant continued to decrease (see table) for a considerable time after the reagent has lost its reactivity and eventually reached a value of $s_0 = c.\ 3$. In a phosphate buffer (*p*H 7) the change was less extensive; but a decrease continued for several days. It appears from this that the decrease in molecular size of the nucleic acid continues after the reagent has been completely hydrolysed. The effect of *p*H suggests slow hydrolysis of the original reaction product, giving rise to comparatively small fragments of the original nucleotide chain. The final molecular weight observed in one case has been as low as 17,000. This very slow breakdown may, of course, have nothing to do with the original effect of the nitrogen 'mustard' which causes the loss of the viscosity.

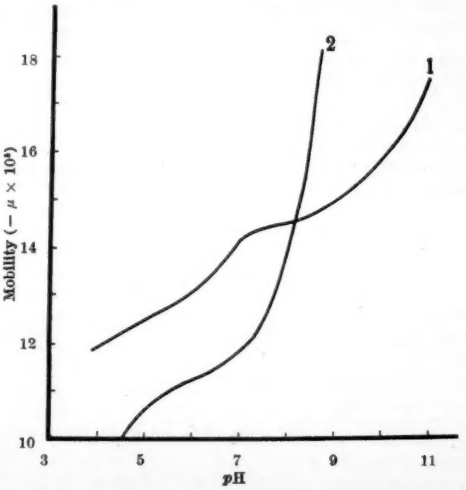
Sedimentation Constants (extrapolated to zero concentration) of Deoxyribonucleic Acid after Treatment with 'Nitrogen Mustard' (I)

In 0·1 *N* sodium bicarbonate	s_0	In phosphate buffer (0·1 *M*) *p*H 7·0	s
Original nucleic acid	15·8	Original nucleic acid	12·2
5 days after adding (I)	7·5	4 days after adding (I)	10·7
7 " " " (I)	6·1	6 " " " (I)	10·0
18 " " " (I)	4·6	7 " " " (I)	9·3
18 " " " (I) and freeze drying	2·2	14 " " " (I)	5·4

Information about the initial action has been obtained from the electrophoretic mobilities of nucleic acid as determined in the electrophoresis apparatus at intervals after the start of the reaction in a phosphate buffer at *p*H 7, and in each case giving the solution 6 hr. dialysis against the buffer with constant stirring to remove the dialysable hydrolysis products. No significant change of the electrophoretic mobility was found to accompany the loss of viscosity or to occur afterwards. The accompanying graph shows the electrophoretic mobilities of a nucleic acid treated with 'nitrogen mustard' over a range of *p*H's. The values of the mobility are not greatly different from those of nucleic acid.

This preparation contains about one 'mustard' residue per tetranucleotide[3], and it was expected that the mobility would be appreciably reduced owing to the partial neutralization of the charge of the nucleate ion. The *effective* charge for unit mass given by $ne/M = \mu(1-\bar{V}\rho)/s$, where μ is the electrophoretic mobility and s is the sedimentation constant, is in general not reduced by the reaction and may under some conditions be increased. This *effective charge* is not, however, easily related to the total charge of colloidal anions, and in the case of *nucleates* it has been shown that the migrating particle contains many gegenions[4]. It would appear, therefore, that the partial neutralization of the charge of the nucleate ion is partly compensated by a decrease in the number of gegenions carried along; that is, those mustard 'residues' which react with the phosphate groups are effectively taking the place of gegenions, so that the effective charge is not decreased. It may, in fact, be increased by this process, because the forces holding the gegenions are the electrostatic attractions of the charged phosphate backbone, and the neutralization at intervals of these phosphate groups by mustard residues will diminish the concentration of charge density on the anion as a whole and so decrease the relative number of gegenions held to the remainder.

If this picture is correct, it is difficult to account for the complete loss of viscosity as a consequence of the *partial* neutralization of the charge by the mustard residues. The partial neutralization of colloidal polymeric ions which form statistical coils, as shown by the theoretical considerations of Kühn[5]



Mobilities of thymonucleic acid: (1) untreated (data of Creeth, Jordan and Gulland (ref. 4)) and (2) after treatment with compound (I) (descending limb of U-tube)

and the experimental results of Fuoss[6] and others, produces a decrease of viscosity; but a nearly complete neutralization of the charge would be required on this basis to give rise to such low viscosities as are observed with 'mustard'-treated nucleic acid. The electrophoretic experiments show that a complete neutralization has not occurred. We conclude, therefore, that these very low viscosities are produced in part at any rate by some other factor. The very low molecular weights observed with the final product suggest that some breakage of the nucleotide chains occurs in the reaction. It is at present uncertain what the molecular weight is immediately after the completion of the reaction, and experiments on this point are being made. A small number of breaks and the consequent reduction of molecular weight of the particles would have a great effect on the viscosity. If the original nucleic acid consists of rod-shaped particles of molecular weight of the order of 10^6, only a few breaks would be required to reduce the viscosity considerably, although other effects of the partial neutralization would also occur.

With regard to the mechanism of such a process, a possibility which is being explored by one of us (W. C. J. R.) is that the tri-substituted phosphate esters produced by reaction with mustard residues of the doubly esterified phosphate groups of nucleic acid are unstable. It has been shown that tri-alkyl phosphates are often less stable than the corresponding di-esters[7], and that the ease of hydrolysis depends to some extent on the nature of the alcohol component. It may therefore happen that the attachment of a 'mustard' residue to the di-esterified phosphate groups present in nucleic acid may result in a preferential hydrolysis of one of the phosphate-sugar links. Experiments are being made on the relative stabilities of di- and tri-phosphate esters derived from radiomimetic compounds to test this hypothesis.

This investigation has been supported by grants to the Royal Cancer Hospital and Chester Beatty Research Institute from the British Empire Cancer Campaign, the Jane Coffin Childs Memorial Fund for Medical Research, the Anna Fuller Fund, and the National Cancer Institute of the National Institutes of Health, U.S. Public Health Service. [Aug. 15.

[1] Conway, Gilbert and Butler, *J. Chem. Soc.*, **3**, 421 (1950).
[2] Butler and James, *Nature*, **167**, 844 (1951).
[3] Press, E. M., and Butler, J. A. V. (unpublished).
[4] Creeth, Jordan and Gulland, *J. Chem. Soc.*, 1406 (1949).
[5] Kühn, Künzle and Katschalsky, *Helv. Chem. Acta*, **31**, 1994 (1948).
[6] e.g., Fuoss and Maclay, *J. Polymer Sci.*, **6**, 305 (1951).
[7] Bailly and Gaumé, *Bull. Soc. Chim.*, **3**, 1397 (1936). Plimmer and Burch, *J. Chem. Soc.*, 279 (1929). cf. Koefed and Tensen, *Acta Scand. Chem.*, **5**, 23 (1951).

PEOPLE AT WORK

THE sixth Present Question Conference was held at Lady Margaret Hall, Oxford, during April 1950. The theme discussed was "People at Work" and brought together individuals from industry and many other walks of life. A report of the addresses and discussion on this extended form of joint consultation in industry has been published in three successive issues of the journal *Question*, the last of which has recently appeared.

The first paper was given by John A. Mack, Stevenson lecturer in citizenship ir. the University of Glasgow, who discussed the reasons why work has become separated from the rest of life. In primitive societies there is no separate word for work and it is accepted as part of the pattern of living. In industrial communities it is something for which incentives are required, an unnatural condition in a more primitive society; human beings in industry are revolting against a system devised exclusively in response to economic and technical requirements. Originally Mack believed that the root of industrial trouble was in the workers' resentment of arbitrary authority. Investigations in many types of firms have convinced him that this is not so. In one factory where production processes are constantly being changed there is considerable stress, not because of the monotony of mass production, but because of the too frequent absence of monotony; strain is the result of the never-ending sequence of minor changes in machines and operations which results from the continuous ingenuity of technical rearrangement. In this factory there would be little point in changing the inter-personal and inter-group relations unless machine processes are reconstituted so that personal strain is eliminated; the machine must be made to fit the man and not man the machine.

This factory example demonstrates the more general conflict between organization and personal integrity in our industrial society. Modern industrial society is activated by two dynamic aspirations. One is to develop the earth's material resources so as to liberate mankind from the curse of poverty. The other is to develop the spiritual resources of the human world by the liberation of personality from the inhibitions of class, and caste, and male domination—from domination and oppression of any kind. The first is partly realized in an economic and industrial system of great ingenuity and power. The second is also realized in part. But the cost of progress has brought the evil of the disruption of what may be called a natural community. Fortunately, people are becoming aware of what is happening and human situations are arising which work against disruption.

In the second address Dr. J. H. Oldham considered the theme of industry and modern society. To-day, it is recognized that our technical, industrial society is involved in a fundamental crisis. The values in which men have believed and lived by for two thousand years have, for an increasing number of people, lost their authority and power of appeal. Industry, too, is involved in a crisis, and has to face the question whether an industrial society can produce and nourish the human qualities which are needed for maintaining society in a state of health. No technical advances, no improvements in organization, not even greater justice in the distribution of the proceeds of industry, will avail anything if the human material on which, in the last resort, everything depends, is inferior in quality. The crisis in which society and industry are alike involved to-day is fundamentally a crisis of men. Industry cannot solve its own problem unless the other forces in society are working in the right direction and lend it support; society cannot solve its crucial problem unless industry plays its part in that solution.

The fundamental cause of the crisis both in society and industry lies in the belief that the whole of life can be mastered by human understanding and that everything is calculable. Man's triumph over Nature has become his enslavement—the enslavement of man to apparatus, technics, mechanization,

organization, the division of labour and centralization. In industry this has been carried to its furthest limits, and economic and technical considerations have ruled out the consideration of man as a human and social being. With Prof. Rosenstock-Huessy, Oldham agrees that the working of the shift system and payment by the hour are both practices which sever man's work from his personal life. The fundamental problem is to find a place for man in an industrial and economic order inescapably subject to technical requirements and natural laws. Man must be helped to gain his self-respect and his sense of relationship, and industry has an indispensable part to play in this re-creation. Happily there is increasing evidence that industry is becoming aware of its human responsibilities and in some ways is already beginning to work out a type of society which is neither individualistic nor collectivist but social, and in which it is accepted that human values are more important than the technical.

Sir Wilfrid Garrett considered the role of work as education, and at first discussed the effects of his first job in industry on a boy who has recently left school. According to Sir Wilfrid the boy finds himself in an environment where he is required to serve a purpose irrespective of what he feels he wants. To help the boy in his confusion industry has to break up its often vague largeness into manageable parts which can be grasped by the individual; the production managers have to realize that they are dealing with human beings. In the case of the young people themselves they should be made to feel that however small a part they play in the industrial machine it is never without meaning because it always serves the good of the community.

Work is also teaching industrial workers at all levels the value of co-operation; and, while there may be need for less craftsmanship in industry, men and women in charge of complicated machines are proud of their charge and the products they produce in relation to the whole. Sir Wilfrid also described the educative value of various training schemes in industry and those organized for industrial workers by such organizations as the Outward Bound Trust, Brathay Hall, and the Young Men's Christian Association.

He was followed by Sir George Schuster on the theme of human relations and production, who stated that what is chiefly needed is the application of already existing ideas; the main practical problem is to get those unprogressive elements in British industry—about 90 per cent—to accept the principles and practices of the others. In the nationalized industries, particularly, the study of human relations should be regarded as a matter of vital importance: in general, one of the grave issues of the post-war world is the moral disintegration which has affected other countries in Europe more than Britain. Another difficulty is that the workers still carry bitter memories of their oppression over a period of more than a hundred years. Nor has educational development kept in step with material development. With Rostovtzeff, Sir George speculates whether it is possible to extend a higher civilization to the lower classes without debasing its standard and diluting its qualities to the vanishing point? "Is not every civilization bound to decay as soon as it begins to penetrate the masses?" Britain has not yet evolved a satisfactory pattern of an educated and democratic industrial society. If human relations in industry are to be satisfactory, three essential conditions must be fulfilled. First, each individual must be treated as an end in himself, and not as a means to an end. Secondly, he must be given the basis for the good life, including his status in society. Thirdly, the individual must recognize that he can only realize himself satisfactorily as a member of a community. Nor can any man lead a good life unless he is doing a good job of work despite those conflicting loyalties born of an industrial society. Here joint consultation properly interpreted is an essential condition for establishing the right kind of human relationships in industry. Nor can 'loyalty' be expected unless the individual really accepts the belief that he 'belongs' to the firm.

Prof. C. A. Mace considered under what conditions work may be made not only more effective but also a source of greater satisfaction to those who do it. In general, work is not attractive or repulsive because of any particular feature in isolation; it depends upon the pattern of the work as a whole. It is not repetition or variety that matters but the ratio of repetition to variety. Everyone needs the element of adventure or risk against a background of fundamental security. In industry to-day there is a lack of balance, a lack of individuality, the worker feeling deprived of the sense of responsibility for an individual task. The new industrial order can be created only by slow progressive stages, taking each job one by one, and by the gradual development and application of new principles, new policies and new procedures of management. Sufficient evidence is already available to show that sub-division, standardization and simplification have been overdone and that efficiency and satisfaction in the job will be enhanced by a reversal of these trends.

To help in understanding how people work in industrial societies, Prof. S. F. Nadel addressed the conference on work in relatively simple, pre-industrial and pre-literate societies. In these primitive societies men mostly work on their own, the typical use of capital, whereby certain individuals pay for the services and efforts of others, being largely unknown. Nor, in primitive societies, do people work so that they may enjoy pursuits out of work; their enjoyments are often so directly connected with the work and its results that the completion of the job, its reward, and the desired enjoyments merge into one.

One important and widespread incentive in primitive societies lies in the work itself. In settled agricultural communities the people always attach great importance to the attractive lay-out of the farms; anthropologists have long been struck by the great importance of display in primitive economy, the chance of displaying success probably acting as the strongest incentive to work. Behind the activity of most individuals is the wish to attain prestige or to win the admiration and approval of others. In other societies where there is a choice of work, like weaving or leatherwork, the individual conceives of his work as being in some measure the concern of supernatural powers. For each individual work is a duty which he does not question, rooted in religious belief and buttressed by the idea that it has been vested in his family or line of descent since times immemorial. For primitive man work may be regarded as a 'passport', if not to social excellence, at least to the fulfilment of an ethical or religious code.

In discussing motivations and the effects of motivation on productivity, Mrs. Winifred Raphael suggested that productivity is an attitude of mind. When there is not a strong motivation to work, there is

poor output and high labour wastage; there is also boredom and discontent. Whether a person is bored or interested in his work depends upon whether he is properly suited to that work; some people are suited by supervisory jobs, and others are most happy when doing apparently dull, routine, mechanical jobs. To be properly suited all individuals should be helped to find the right job when they leave school and, later, in any change they make; and, when labour is short, it is most important to use the labour force to the best advantage. It was Sir Walter Raleigh who said, "The nightingale did not win a prize in the poultry show"; a real attempt must be made to match the person to the job and the job to the person. Boredom or interest will also depend upon the extent to which the individual participates in the affairs of the firm; this may be encouraged by formal and informal joint consultation. Interest also depends upon the social environment and, for many people in industry, what matters most is neither the job nor the pay but the people they are working with; workers' solidarity is one of the strongest motives in industry.

Probably, however, the greatest effect upon motivation depends upon whether an individual feels he is being fairly treated; pay is always thought of in relation to other individuals. Another factor affecting motivation for or against work is whether individuals are repressed or encouraged; pride in the job is an important incentive. Training is also important since the individual feels that opportunities for training may lead to promotion.

After discussing motivating forces in general, Mr. E. W. Hughes advocated the use of intelligent rather than sentimental control of the prime urges to action. Among the more permanent incentives he regarded the need to satisfy self-expression through some activity as one of the most important, especially if the effort is recognized by the group in terms accepted by the group. Mr. Hughes has had special experience in the mining industry, and here, although many motivation problems are similar to those of other industries, the industry still has a long leeway to make up in certain conditions of work. But the effort is being made, and the National Coal Board is making a genuine and not unsuccessful attempt to remove factors which cause accidents, the stigma which goes with dirty faces and dirty clothes, and other deterrents. At Keresley Colliery, near Coventry, for example, the surface lay-out is such that, but for the pit-head gear, the colliery could be mistaken for a light engineering factory. In South Wales the casualties caused by dust resulted in a drift from the industry. The dust problem has been energetically tackled, and miners are returning to the industry.

Among the reasons why people enter the coal-mining industry is security of tenure. This is particularly true of young men and, for them, various apprenticeship and training schemes have been devised. Good wages have not the incentive value usually described, as is shown by the reduction of the mining labour force despite considerable increases in pay. Mr. Hughes also expressed the need for an extended system of joint consultation at horizontal levels in the mining industry.

In his address on organization and the person Mr. R. W. Latham suggested that joint consultation is not consultative procedure but an attitude of mind. Nor is it new despite the official introduction of joint consultation to industry by Sir Stafford Cripps in 1942; some small firms in Britain had established machinery for joint consultation in the eighteenth century. Mr. Latham also pleaded for the use of *ad hoc* committees in those departments of a factory which have particular problems. But he could not agree with other speakers who believed that, apart from wages negotiations, confidential matters to the firm and about individuals, nothing should be barred from discussion at works councils. According to Latham, most workers do not understand balance sheets or market research, and he advocated the education of industrial employees as one of the most urgent needs of to-day; this should be undertaken by the trade unions themselves. The majority of workers do want to participate in the activities of their firm, but, despite the clamour of a small minority, they do not want control.

In the ensuing discussion probably the most interesting point which arose concerned the profit motive and the social purpose of industry. This was summarized by one speaker as consisting of three main factors: first, it is generally accepted that private industry cannot be allowed to follow its own way without an ethical code; secondly, bureaucratic control is bad for industry because it is so negative; thirdly, there is a considerable and justifiable demand for participation in the control of industry and responsibility for running it by all who are engaged in it.

T. H. Hawkins

INDUSTRIAL RADIOLOGY GROUP OF THE INSTITUTE OF PHYSICS

SUMMER MEETING

THE summer meeting of the Industrial Radiology Group of the Institute of Physics was held at the Institute's House, 47 Belgrave Square, London, S.W.1, during July 23–25. A programme of lectures, covering a wide field of interest to the industrial radiologist, was arranged. One of the most interesting was that by Mr. L. van Ouwerkerk (Röntgen Technische Dienst, Holland), with the title "Xero-radiography", which it was explained is a dry method without the use of photographic films and is at present in the laboratory stage.

Mr. van Ouwerkerk stressed that his was largely a report of what had been done in the United States on this subject. Starting with a description of the application of xerography to photography, he described how a layer of photo-conducting insulating material, deposited on a metal plate, is charged and then exposed to light, with the resultant leaking away of the charge in proportion to the light falling on any spot. This latent image is developed by dusting with a fine powder which adheres only where the plate is charged. Prints can be made by transferring and fixing the powder image to paper. In elaborating these points Mr. van Ouwerkerk described in detail the requirements of the photo-sensitive plate as regards electrical conductivity and how it is charged under corona discharge, as well as the action of incident light in discharging it. He said that the latent image can be retained on the plate for several days, and described how it is developed by a powder mixture consisting of a fine resinous powder and a granular carrier of relatively large particle size, which serves to generate a charge on the smaller powder particles.

This powder image can be transferred to paper, plastic, material, etc., charged with the opposite sign and placed in contact with it, and is then fixed by fusing the resinous powder.

In considering the application of the method to radiography, Mr. van Ouwerkerk said that the inherent unsharpness due to grain size is better than for photographic film. Finer powders are used for development than in the case of xerography. One interesting point is that a crack in the object being radiographed gives an enhanced effect due to the localized charge there. The method has been successful with energies between 5 kV. and 10 MeV., exposure times required being somewhat less than for X-ray films. Good definition is obtained. In concluding, Mr. van Ouwerkerk said that the obvious advantages of the method make it merit our attention in the future.

In opening the discussion on Mr. van Ouwerkerk's paper, Mr. D. T. O'Connor related his own experiences with xeroradiography. The materials are inexpensive, the main difficulty being the selenium-coated plate, produced by the vacuum coating technique. For charging the plate almost any material is suitable, such as powdered charcoal, the cloud method being the simplest process. In this the powder is blown through a tube by means of compressed air into a box containing the plate. Mr. O'Connor spoke of the high cost of X-ray films for radiography and of their possible scarcity. Mr. van Ouwerkerk said that some loss of sensitivity is unavoidable in making permanent records by fusion of the sprayed powder ; but it should be possible to compensate for this to some extent by increasing the contrast in copying. The only limitation in the size of the plate is in obtaining a uniform coating of selenium. Metal intensifying screens must, of course, not be in metallic contact with the plate, but this does not appear to cause loss of definition. He agreed that atmospheric humidity may cause some loss of charge of the plate.

One morning session was devoted to a symposium on "Penetrameters", and in introducing this Mr. J. C. Rockley (Aeronautical Inspection Directorate, Harefield) stated that a wider use of these is desirable ; but that guidance is needed in their correct use, since the results obtained from different types do not always agree. He said that the function of the penetrameter is that of quality control, and in his opinion the step type gives a good idea of sensitivity and contrast, while the wire or ball type gives an idea of definition. He concluded with some remarks on deciding the position of the penetrameter on the specimen.

The principal speaker in the symposium, Mr. B. Schuil (Röntgen Technische Dienst) started by criticizing the name 'penetrameter', since the device neither measures nor expresses any quality in accepted units. penetration cannot, he claimed, be measured by expressing it as thickness-sensitivity, that is, the percentage of the wall thickness indicated by the last visible step or wire, since this depends on both geometry and exposure technique. A true penetrameter should compare the intensity of radiation after passing the object with that of the primary beam. In asking why we use penetrameters, Mr. Schuil said that their use means getting the best penetrameter image as regards contrast and definition. He gave as an example a case in which, by using salt screens instead of lead screens, a higher sensitivity was obtained due to greater contrast, in spite of the poorer quality image. But an optimum penetrameter image does not, he maintained, guarantee a sound object ; many other factors influence the detection of flaws. Again, with very hard radiation, the absolute flaw sensitivity increases, and it is not possible to express it as a percentage of the plate thickness ; rather, a certain minimum thickness can be revealed. Regarding different types of penetrameter, Mr. Schuil said that there is no ideal form, but he prefers, in general, those using wires to those using step-wedges or test plates, such as are recommended by the boiler code of the American Society of Mechanical Engineers. He concluded with some remarks on the practical use of penetrameters and the ideal penetrameter.

In opening the discussion on penetrameters, the chairman, Mr. C. Croxson (Armament Research Establishment, Woolwich), pointed out the advantages of having separate checks for definition and contrast, as embodied, for example, in the Ministry of Supply penetrameter. As a check on definition he suggested (*a*) fine wires of material similar to that of the specimen for use with small thicknesses, and (*b*) drilled holes in a plate, of similar material to that of the specimen, about 0·02 in. in diameter and of minimum depth to give just perceptible images ; the latter for use with thick specimens. Mr. O'Connor said that a test object of comparatively large area is needed to assess contrast, and one of small area to assess definition. He expressed no particular preference for the step wedge type over the strip type used by the American Army Ordnance. Dr. A. Nemet pointed out the interrelation of contrast and definition; and while Mr. Croxson agreed, he said that nevertheless a more sensitive penetrameter can be made by having separate checks for the two, as he had suggested. Mr. E. Owen (Hadfields, Ltd.) said that he has found that the ball type of penetrameter has the poorest sensitivity. Other points made were the desirability of an identification mark as an integral part of a penetrameter ; the necessity for a robust inexpensive construction ; and the desirability of flexibility for penetrameters to be used on curved surfaces. The comments appeared on the whole to favour the wire type of penetrameter, but it was evident that it is as yet premature to consider the standardization of any particular types.

At further sessions Mr. D. Bromley (Admiralty Materials Laboratory, Poole) spoke on "An Analysis of the Quality of Radiographs", Mr. J. Rhodes (Royal Ordnance Factory, Woolwich) on "Gamma-ray Stereography", and Mr. H. Vinter (Denmark) on "The Correlation of Radiographic Results with Weld Strength". A comprehensive paper describing non-destructive testing in Germany was read for Prof. R. Berthold (formerly of the Reichsröntgenstelle, Berlin) in his absence, and Mr. E. van Someren (Murex Welding Processes, Ltd.) gave a paper entitled "Short Range Radiography". The meeting concluded with a symposium on "The Site Radiography of Pipe Welds", at which Mr. F. H. Gottfeld (Solus Schall, Ltd.) and Mr. R. V. Walker (Ministry of Supply) were the principal speakers.

An exhibition of apparatus of interest to the industrial radiologist, arranged by Mr. J. C. Rockley, was held concurrently with the summer meeting and comprised six sections. The first illustrated radioactive materials in industrial radiography and showed, as an example, the construction of a radiographic source containing radon and the extraction of the necessary radon. Further exhibits showed containers for gamma-ray sources and devices for handling them, a total of nine exhibits. Six of these were available

commercially, and the remainder had been designed by individual radiologists to meet their own needs. Protection was covered in this section by a selection of portable monitors, dosemeters and film badges suitable for workers with gamma-rays. Further exhibits showed the lay-out of X-ray laboratories by means of a model and photographs, as well as samples of many of the protective materials on the market. A section of outstanding interest showed by means of specimens the development of X-ray tubes from 1896 to the present day, mostly loaned by Messrs. Newton Victor, Ltd. In a section devoted to special applications of X- and gamma-rays, interesting examples were those on the use of X-rays in micro-radiography by the Bristol Aeroplane Co., Ltd., the autoradiography of radium and radon containers as a check on the correct distribution of the radioactive material by the Radiochemical Centre, Amersham, and electron radiographs of bank-notes taken by the Atomic Energy Research Establishment, Harwell, from the scattered electrons using an iridium-192 source. The section on stereoradiography, arranged by Ilford, Ltd., showed some striking applications of stereo work in radiography, together with examples of the apparatus required for this work. The section on radiographs covered a wide field in which twelve firms exhibited. Johnson Matthey and Co., Ltd., showed radiographs of brazed fittings, and Kodak, Ltd., had an instructive exhibit showing how gratuitous markings on the film due to various external causes can mislead the radiographer. Exhibits by the Aeronautical Inspection Directorate and the Atomic Energy Research Establishment showed the wide range of problems ranging from plywoods to wire-wound resistors that had been dealt with by these establishments. A final section showed a working model of a beta-ray thickness gauge.

B. N. Clack

EFFECT OF COLD ON MICRO-ORGANISMS

THE autumn meeting of the Society for Applied Bacteriology was held in the lecture hall of the London Medical Society on October 23, when a symposium was held on the subject of "The Effect of Cold on Micro-Organisms". There were about 120 members and visitors present.

Dr. A. T. R. Mattick (National Institute for Research in Dairying) opened the symposium by a short historical survey of the subject. He described how the lethal effect of freezing on bacterial cells, originally thought to be due to the crushing mechanism of ice crystals, has now given way to the concept of protein denaturation and precipitation. This is due to the classical work of Haines in 1937, who found that freezing at temperatures between −5° and −70° C. had no effect on the mortality of *Pseudomonas* species of bacteria, but that temperature is significant for survival on storage. Between −1° and −20° C., greater death-rates were found at the higher temperature, the critical maximum being −2° C. Extending these observations further, Weiser and Osterud in 1945 emphasized the difference between immediate death caused by the action of freezing, which is independent of temperature, and storage death, which is dependent on temperature and time. Storage death-rates are lower at temperatures below −30° C. than at temperatures above this value, such that at −195° C. no deaths appear to take place.

The limiting temperature below which all organisms cease to grow is about −8° C., although many bacteria will remain viable for long periods below this temperature. For example, *Streptococcus fæcalis* has been found viable in cheese after seven years at −15° C., and coliforms and *Pseudomonas* species have been found in butter. The metabolism of many bacteria is affected by reduced temperatures, the effect being largely that of change from saccharolytic to proteolytic and lipolytic action.

Dr. J. G. Davis (United Dairies, London), discussing the effect of cold in relation to dairying, said that the changes in metabolism which many bacteria undergo at reduced temperatures often give rise to pigment formation; for example, *Pseudomonas* can readily produce colour in milk and has been known to impart a blue-black pigment to butter. Probably more significant is the bitter, or sometimes 'oxidized' or oily, taste acquired by milk due to the lipolytic activities of micro-organisms. Plate counts on such milk samples may not be significantly affected; but the methylene blue test shows a marked decline. It is doubtful whether any cryophilic organisms can survive pasteurization, but obviously any which might escape such treatment will be liable to exert an adverse effect on the milk.

Ice cream of good quality can be stored satisfactorily at −10° C., at which temperature the bacterial count tends to fall; and, contrary to early opinion, cheese can be ripened at low temperatures and gives a better product free from bitter taste.

Dr. M. Ingram (Low Temperature Research Station, Cambridge), dealing with cold in relation to the microbiology of foods, said that all spoilage is due in the first place to the activities of micro-organisms. Freezing, however, is not always possible with many foodstuffs—for example, fruit and meat—and chilling only can be employed. The Q_{10} value of 2, which usually obtains in chemical reactions, is subject to much variation in bacteriology and depends very much on the species of micro-organisms being considered. It is, in fact, much higher than 2 at lower temperatures; hence a difference of only 1 or 2° C. at these levels may have a considerable effect on rate of spoilage. With all tissue material, especially the living tissues of fruit, a balance has to be sought between tissue damage or death and bacterial rot.

In general, pathogenic organisms cease to grow below about 5° C., *Bact. coli* at −5° C., and *Achromobacter* and *Pseudomonas* species at −3° C. Staphylococci and spore-forming bacteria do not suffer a high mortality on freezing, but most other types do. Mortality and storage death-rates are reduced by such substances as sugars and glycerol, and osmotic pressure plays a considerable part.

Enzyme action is not stopped by cold at anything like the same rate as bacterial growth; hence much lower temperatures are necessary for the preservation of some foods such as peas, herring and bacon.

Mr. H. Proom (Wellcome Physiological Research Laboratories, Beckenham) described some problems associated with freeze-drying. Freeze-drying for biological purposes was first described in 1909 by Shackle. Later, in 1933, Flosdorf and Mudd used a manifold process, and afterwards sublimation and spin-freezing methods were developed.

The effect of freeze-drying on the viability of bacteria varies with the species and the medium employed; but the importance of the process is in

the fact that organisms so treated retain completely their serological characteristics, toxin production and other physiological properties for very long periods of time. Bacteria suspended in saline alone have a poor survival-rate; but the addition of broth, serum or gelatin exerts similar protective actions. Serum is suspect because of its hygroscopic nature and the consequent deleterious effect of moisture on the organisms.

Survival-rates after drying are dependent on a number of factors, including temperature; for example, reported comparative rates at 4° and at 37° C. are 83 per cent and 28 per cent respectively. The relationship between storage loss and time is allied to losses on heating at temperatures between 60° and 100° C., and short heatings at these temperatures can give a measure of storage survival. In spite of reports that there is an optimum small residual moisture content for maximum survival, it now appears quite certain that such an optimum is not obtained, and greatest survivals are found in the driest preparations. It is desirable also to include a suitable reducing substance to prevent oxidation, and the gaseous atmosphere under which the dried material is sealed is important. Dry nitrogen or sealing *in vacuo* gives the best survival conditions, the rates being nine or ten times better than those with oxygen or air.

Following the main papers there was active discussion and questioning, during which two comments were made on changes observed in properties of bacteria on freezing and thawing. One concerned the destruction of phage associated with lactobacilli, and the other, changes in antigenic reactions of some streptococci. Mr. Proom said this was the first evidence he had heard of any change produced by freezing, and the suggestion was made that it may be due to the high and selective death-rate leaving a residue of viable cells which might not be fully representative of the original.

In reply to other questions, Dr. Ingram said that moulds will grow readily in chill rooms, and that flowing air and reduction of relative humidity to less than 96 per cent will practically stop the growth of bacteria.

COMMONWEALTH OF AUSTRALIA SCIENTIFIC AND INDUSTRIAL RESEARCH ORGANIZATION

REPORT FOR THE YEAR 1949–50

THE second annual report of the Commonwealth of Australia Scientific and Industrial Research Organization* has been published, for the year ended June 30, 1950. The Organization, which now comprises sixteen Divisions, as well as several independent Sections and five regional centres, continues to face great difficulties in developing its research programmes because of the lack of suitable buildings, and many Divisions are working under crowded and difficult conditions. Work is proceeding throughout the Commonwealth on the mapping of soils and the determination of their physical and chemical properties.

* Second Annual Report of the Commonwealth Scientific and Industrial Research Organization for the Year ending 30th June, 1950. Pp. 157. (Canberra: Commonwealth Government Printer, 1950.) 9*s*.

Further progress is reported in the development of spectrochemical techniques for analysing soil and plant material. Some fundamental work on the downward flow of water into soil was completed, and the magnitude of movements of water in soil due to temperature gradients investigated. Soil microbiological studies centred mainly round *Rhizobium*, the genus of bacteria responsible for the nodulation of leguminous plants, and the investigations commenced in 1947 into its establishment in field soils, have been concluded.

The general programme of work on pastures continued on the same basis as in the previous year; at Canberra three systems of grazing management were being compared on a *Phalaris* – subterranean clover pasture, and at the Dickson Experiment Station a series of long-term trials on the relation of pasture and cropping practice to soil fertility trends, and especially on the factors involved in such changes in fertility, was being initiated. An ecological survey of vegetation and pastures at Trangie, New South Wales, was nearing completion, while at Deniliquin, New South Wales, investigations have been completed on irrigated pastures; these were begun in 1949 to determine the factors involved in the emergence of pasture and forage species sown in various conditions and depths and with different treatments of organic litter and fungicides. Weed investigations have included studies on the use of plant growth-regulating substances for the control of perennial weeds, the mechanism of action of such substances, and the control of perennial grass weeds; and, besides the trials of new pasture and forage plants, investigations with linseed and other vegetable oil plants have continued. Search has been made for apple rootstocks which give better performance under Australian conditions and also for improved rootstocks for pears and plums. The general results of the opium poppy improvement programme were published during the year, and the survey of native plants for sources of substances of pharmacological value and chemical interest has been concerned mainly with the Queensland flora. The promising prospects for expanding tobacco production by irrigation during the 'dry' season in northern Australia have opened up a new field of research requiring immediate attention. Among plant disease investigations may be mentioned those on potato virus *X*, the use of plant tissue culture techniques for controlled studies of virus recovery phenomena, and the control of 'dollar spot' (*Sclerotinia homœocarpa*) on turf by fungicides; a study of the effect of nutrition on the development of *Fusarium* wilt of tomato was concluded.

Other plant investigations are carried out at the irrigation research stations at Merbein, Victoria, and at Griffith, New South Wales, the former being concerned with the problems of irrigated horticultural lands of the middle and lower Murray, particularly the cultivation and processing of grapes, and the latter, besides studies on irrigation and soil salting, being concerned especially with the development and nutrition requirements of such crops as oranges and vegetables. Successful control of hardhead (*Centaurea picris*) with the weedkiller 'Hormex' and of hoary cress (*Lepidium draba*) with 'Methoxone' and 'Hormex' is reported.

The Division of Animal Health and Production, which has its headquarters in Melbourne, has been concerned mainly with problems in the sheep and cattle industries. Besides a further study of the nutritional factors which determine wool production,

this work on sheep has included studies of the processes of rumination, the toxicity of large rations of wheat, the effect of cobalt and copper deficiencies in nutrition, the physiology of reproduction, biological studies of the growth of skin and wool, the efficacy of phenothiazine against the large-mouth bowel worm (*Charbertia ovina*), resistance to nematode infestation, and the value of DDT and BHC preparations in preventing body strike as well as tests with insecticidal fogs for this purpose. Cattle investigations have included studies on pleuropneumonia, tuberculosis and brucellosis, the value of antibiotics in eliminating udder infections, the epidemiology of parasitic gastro-enteritis of cattle; the ecology of the non-parasitic stages of the cattle tick and bio-assay tests with a number of chlorinated hydrocarbons and organic phosphates which permit the division of potential ascaricides into three main classes. Other work on nutrition has embraced studies of the influence of copper or zinc deficiency on the phosphorus metabolism of Algerian oat plants in aqueous culture, on accessory food factors and on the reactions of amino-acids.

Some of the work which has been here noted was carried out in association with the Division of Entomology, which, besides work on various aspects of insect physiology, made an intensive field study of the control of St. John's wort, *Hypericum perforatum* L., with *Chrysomela hyperici* and *C. gemellata*. Encouraging results were also obtained in the biological control of the cabbage moth, *Plutella maculipennis*, with the ichneumonid parasites, *Angitia cerophaga* and *Diadromus collaris*. Preliminary work on population dynamics has been based on the sheep blowfly, and work has continued on the ecological control of the Australian plague locust, *Chortoicetes terminifera*, and on the distribution and ecology of the pasture cockchafer, *Aphodius howitti* Hope. The Wild Life Survey Section, established early in 1949, has been solely concerned with basic ecological studies on the rabbit, further trials of the virus disease, *Myxomatosis cuniculi*, and of poisons for the same pest (see *Nature*, Dec. 1, p. 932).

Fisheries investigations included work on the races of the Australian salmon (*Arripis trutta*), a survey of tuna resources in northern Australia, a study of barracuta in the Bass Strait area, further investigations of the properties of the deep waters off Rottnest Island, Western Australia, and continued surveys on crayfish and sand crabs. Work on pilchards is described in two papers to appear in the new periodical, the *Australian Journal of Marine and Freshwater Research*, publication of which commenced in April 1950 (see *Nature*, **166**, 719; 1950). Food research included investigations on the anaerobic destruction of ascorbic acid, on the natural coating of apples and on protein denaturation. Investigation of the factors affecting the germination of heat-treated spores continued, as well as of the effects of oil and other coatings applied to the shells of eggs before storage, the variability in the storage behaviour of apples, the canning of peas, the dehydration of fruit and meat, and the drying of sultanas. Studies on the incorporation of skim milk powder in bread have been resumed and those on the chemistry of the taint in butter caused by *Coronopus didymus* continued.

Work has continued in the Division of Forest Products on wood structure in relation to properties, the chemistry of wood, creep in wood, the physical properties of wood and related materials, timber mechanics and seasoning, as well as on the toxicity and permanence of water-borne preservatives and on veneer and plywood manufacture. The status of the Building Research Section has been raised to that of a Division, and the experimental work on foamed concrete continued. Investigations on surfacing materials have included a study of the physiological effects of the thermal and mechanical properties of concrete floors, while the acoustic behaviour of rooms and halls, the suitability of bituminous membranes for flat roofs and the efficiency of the inter-layer bond of membranes of various kinds as well as the sulphide staining and growth of mould on water-paint films on fibrous plaster are all being studied. A new Wool Textile Research Laboratory was being organized in each of the three major textile centres—Melbourne, Sydney and Geelong—and studies were being made on detergency in connexion with wool scouring, the aliphatic alcohols of wool wax, the recovery of wool from skin pieces by complete digestion of the skin pieces, the application of resins to wool, the action of shrinkproofing agents on wool, the structure of the cuticle of wool fibre, and the molecular structure of amino-acids, lower peptides, synthetic polypeptides and natural fibrous proteins. In the Flax Research Laboratory efforts have been made to devise methods of carrying on the retting bacteria from ret to ret so as to avoid the necessity of inoculating each ret separately.

In the Division of Industrial Chemistry, promising results have been obtained in the refining of sugar-cane wax recovered from waste materials from the sugar mills, while a project on the utilization of brown coal provides the basic data for a programme for producing liquid fuels and organic chemicals from the extensive low-grade coals of Australia. A report on the clay resources of South Australia was in preparation, and extensive research to improve the performance of refractories, particularly for the gas and cement industries, was in progress. Other investigations include the application of surface chemistry to the study of the flotation of minerals, the kinetics of the phenol-formaldehyde condensation and the physical properties of fluids at high pressures. In the Section of Physical Metallurgy work on the strength and structure of metals has been continued, particularly on the mechanism of failure by fatigue and the influence of rate of strain on the mechanism of deformation at high temperatures; but attention has been given chiefly to the constitution and properties of alloys of titanium, the allotropy of titanium and the creep of lead alloys.

The Division of Tribophysics reports further progress in the study of friction and lubrication, and plastic deformation and phase changes of metals. The work of the Division of Metrology has been largely directed towards meeting the requirements of the National Standards Commission and so enabling the Weights and Measures (National Standards) Act, 1948, to be proclaimed. Much of the work of the Division of Physics also consisted in research on the maintenance of standards and on methods of accurate measurement. The Division also investigated the composition and temperature distribution of the solar atmosphere, and a spectroheliograph which will take photographs of phenomena such as flares and prominences on the sun's surface is being constructed. Much work has also been done on the construction of equipment for researches on the properties of matter at very low temperatures and for the measurement of the elastic properties of wool

by supersonic techniques. In the Division of Electrotechnology, besides work on electrical measurements and standards, the dielectric properties of materials have been investigated with particular reference to the mechanism of dielectric loss. In the Division of Radiophysics further advance has been made in the knowledge of the radiofrequency radiation which reaches the earth from the sun, from radio-stars and from the galaxy, as well as in our understanding of the processes by which natural rain occurs; and a new programme of radio and radar aids to navigation was introduced, including microwave direction-finding and relay radar. The Organization has also been co-operating with the University of Melbourne in research on nuclear physics and cosmic rays under the direction of Prof. L. H. Martin.

LABOUR TURNOVER AND ABSENCE IN GREAT BRITAIN UNDER FULL EMPLOYMENT

IT is generally believed that rates of labour turnover and absence in Great Britain have been higher under full employment than they were before the Second World War, and constitute a substantial obstacle to industrial efficiency; but hitherto there have not been records in sufficient detail to reveal the course and causes of turnover and absence in a particular setting. Accordingly two monographs* published by the University of Birmingham Faculty of Commerce and Social Science—"Labour Turnover under Full Employment", by Dr. Joyce R. Long, and "Absence under Full Employment", by Hilde Behrend—are important. They report and analyse the experience of factories in the Midlands, employing between them upwards of sixty thousand persons, mostly in engineering and metal working. The collection of this material was made possible through the Midland Advisory Council on Industrial Productivity.

Each monograph sets out what evidence there is for the difference between recent working and that of the interwar years. Such evidence is scanty; but, so far as it goes, it shows less difference than common report suggests. A survey by the National Institute of Industrial Psychology[1] in 1937 gave annual turnover-rates of 18 per cent for men and 51 per cent for women in a sample of London firms, and 11 per cent for men and 34 per cent for women in a Leeds sample. Records for 1949 collected by the British Institute of Management give rates of 21–24 per cent for men, and 38–41 per cent for women. Rates vary so much from firm to firm that generalizations from samples are hazardous; but these inquiries at least show considerable overlap between the pre-war and post-war ranges. As regards absence, the only continuous record is that for the coal miners, and, though the percentage of possible shifts missed has been around 12 of recent years as against 6 before the War, Miss Behrend in her monograph shows that this is due to a rise in the number of possible shifts rather than to a fall in attendances, which remain fairly steady, now as in the interwar years, around 4·7 shifts a week.

The main finding of Dr. Long's study of turnover is perhaps that the rate of turnover depends on the type of worker rather than on the type of firm, and that some types of worker have high rates of turnover whereas the majority are stable. She calculates a stability-rate, defined as the percentage of a firm's employees who have not left it during a certain period, and finds that the same firm may have both a high stability-rate and a high turnover-rate. Herein lies much of the explanation of the negative relation which she shows has generally held between unemployment and turnover: turnover is lower when unemployment is high not because all types of labour change jobs less often then, so much as because the unemployed contain a high proportion of types whose turnover-rates are habitually high. The characteristics associated with such rates are chiefly youth, lack of skill, and coming to work from a distance. Long service may be a source of stability; but it is hard to separate this influence, for those who have stayed on will be those who were more stable initially. Women usually show higher rates than men; but much of this seems to depend on lack of skill rather than on sex, for men doing unskilled work often have rates as high as the women, or higher. By contrast with these personal factors, the conditions of employment, such as the size of the firm, the level of pay and the working environment, show no clear association with the turnover-rate, though some differences between the rates of otherwise similar groups of workers are attributable to the state of personal relations in the plants, and especially the quality of supervision.

The special contribution of Miss Behrend's study of absence is the means it proposes for measuring controllable and uncontrollable absence separately. One element of the uncontrollable part is 'unavoidable' absence due to sickness, accidents and family affairs; but Miss Behrend holds that there is a further element which likewise is largely beyond the power of management to control because it is inherent in the nature of the work and of the labour force this work attracts. A sample of daily absence-rates shows marked differences between one day of the week and another, with Friday usually the lowest, and a given plant or department seems to have a characteristic and persistent weekly pattern: Miss Behrend suggests that it should take its Friday-rate as the measure of the uncontrollable absence specific to it, and the excess of absence on other days as the measure of controllable absence (see *Nature*, **165**, 831; 1950). More particularly, she proposes a 'Blue Monday' index, giving the shortfall of Monday's attendance below Friday's as an indication of the workers' attitude to their work. In a study of two companies she finds that the 'Blue Monday' index is not correlated with the total absence-rate, for this depends mostly on sickness and workers' ages, whereas the 'Blue Monday' index singles out voluntary absenteeism. This is high among short-service workers and where work is unskilled or is reckoned to impose psychological strain, but it does not seem to be associated with other working conditions.

These studies collect evidence on an important problem on which exact information has hitherto been scanty in Great Britain. Their analysis of it is thorough, suggestive and directed towards practical application. It shows how collaboration between industry and the universities in this field can yield results useful to industry.

E. H. PHELPS BROWN

* University of Birmingham Studies in Economics and Society. Monograph A.2: Labour Turnover under Full Employment. By Dr. Joyce R. Long (pp. 134). Monograph A.3: Absence under Full Employment. By Hilde Behrend (pp. 137). (Birmingham Faculty of Commerce and Social Science, 1951.) 15s. each.

[1] *Occupational Psychology*, 12, Nos. 3 and 4 (1938).

LETTERS TO THE EDITORS

The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications

Mutation in a Bacterial Virus

In a recent paper[1], data have been given which suggest that certain of the symbiotic bacterial viruses (bacteriophages) found in *Salmonella typhi-murium* undergo diphasic variation. The normally innocuous symbionts occasionally throw off lytic mutants which multiply actively and destroy the host bacterium. This leads to the liberation of virus particles, some of which, when brought in contact with a susceptible host bacterium, develop as symbionts and reproduce the original type of infection, while others are lytic in nature and multiply actively at the expense of the bacterium. Of the particles generated in this lytic cycle the majority are themselves lytic; but a minority—perhaps about 5 per cent—are potential symbionts. In cultures on solid medium the latter produce symbiotically infected and hence 'immune' bacteria which multiply unscathed and form the characteristic 'solid centre' of the plaque.

Another kind of mutation has now been observed which is common to most, if not all, the Group *A* phages of *S. typhi-murium*. The mutants in question can be recovered either from the supernatant fluid of a spun broth-culture of the symbiotically infected (lysogenic) strain, or from the lysate resulting from the action of these phages on an indicator strain. To detect and isolate them, a suitable dilution of either type of lysate is flooded over an agar plate sown with the indicator strain. This plate is incubated overnight. A careful search may reveal, among the characteristic 'solid centre' plaques, an occasional one showing a varying number of small granules on a clear background (Fig. 1). Such plaques may, in exceptional cases, be relatively common; but usually they are scanty, and several plates carrying many thousands of 'solid centre' plaques may be searched before one such mutant is found.

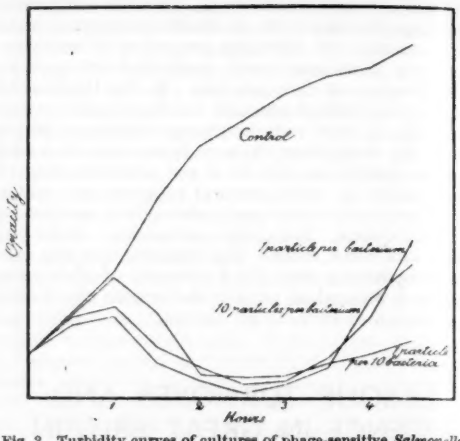


Fig. 3. Turbidity curves of cultures of phage-sensitive *Salmonella typhi-murium* initially exposed to the action of different concentrations of lytic mutant

When cultivated on an indicator strain of bacteria, these mutants in the main breed true, and show no tendency towards a general reversion to the type of particle which produces 'solid centre' plaques. Nevertheless, particles of this kind do occur, though with great rarity, in cultures of the lytic mutant, and can be identified by a corresponding technique (Fig. 2). The lytic mutants have the same antigenic structure as the strain from which they were derived, and the same resistance to heat, being able to survive exposure to temperatures of 80° C.

The organisms which make up the granules within the plaques are *not*, as in the case of the 'solid centre' plaques, symbiotically infected. The majority are phage-sensitive, and appear to exist in a state of balance with the virus. A minority are phage-resistant, and after more prolonged incubation some may be both rough and resistant. In most respects these mutants resemble the *N* phages described by Burnet[2].

The lytic character of the mutant is well shown by the turbidity curves of a growing culture of an indicator bacterium exposed to different concentrations of particles (Fig. 3). As with the familiar lytic phages, the higher the concentration of particles, the earlier the onset of lysis and clearing. This is in contrast to the curves which result when the same experiment is carried out with the parent virus where, in the presence of a high concentration of particles, no very obvious bacterial lysis occurs because significant numbers of bacteria become symbiotically infected and continue to multiply (Fig. 4), a

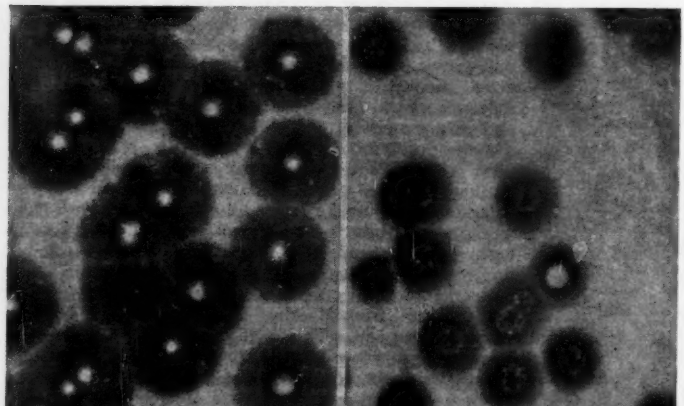


Fig. 1. Plaques of phage *A*1 showing a lytic mutant among normal 'solid centre' plaques. × 5

Fig. 2. Plaques from a culture of the lytic mutant showing a single 'solid centre' plaque, one of two found in sixteen plates examined. × 5

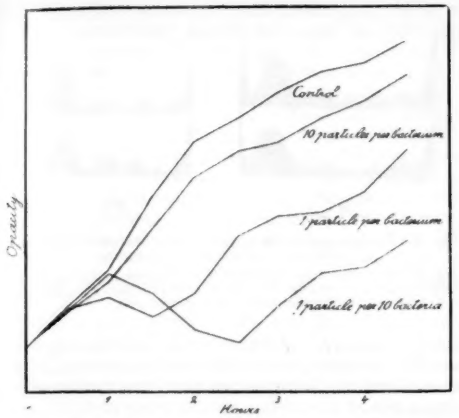


Fig. 4. Similar to Fig. 3, but exposed to virus of the type which undergoes diphasic variation, and produces 'solid centre' plaques

result which parallels the development of the 'solid centre' in the plaque.

The recognition of these stable lytic mutants is further evidence in favour of a suggestion previously made—that lytic (virulent) bacterial viruses have their origin and continuing source in innocuous parent symbionts, and represent only a single phase in the life-history of the virus.

Details of this work will be published elsewhere.

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Transplantation of Mouse Eggs

The transplantation of mammalian eggs into a host uterus is usually achieved by means of an operation on the recipient female. It would clearly be of advantage in several respects if transference could be effected without the necessity of opening the body cavity of the recipient. As described below, mouse eggs transferred directly through the cervical opening into a host uterus have come to term. This seems to be the first mammal in which a direct non-operative transplantation has succeeded. It is suggested that the procedure could be called 'inovulation', by analogy with the word insemination[1].

Fertilized mouse eggs were obtained in the usual way from the uterus or Fallopian tubes of a previously mated female, sacrificed for the purpose. The apparatus (a 1-c.c. syringe bearing an obliquely blunted needle of about 0·2 mm. internal diameter), and the general procedure, were as described by Snell, Hummel and Abelmann[2] for artificial insemination of mice, except that a 4-in. needle was thought to lessen the danger of losing eggs in the lumen of the syringe. The eggs, held in the lumen of the needle in Pannet–Compton solution, were expelled into the uterus of a recipient female, the sexual cycle of which had been set into operation by mating with another male. Eggs were transferred to one horn only of the recipient uterus. Genetic marks were arranged to enable the young born of transferred eggs to be distinguished from the young of the recipient female itself (for example, transferred embryos homozygous albino, host embryos homozygous non-albino). Tested sterile males, homozygous for the dominant marker Rex as an extra precaution, were sometimes used to activate the recipient female, and the young born in two such cases were necessarily derived from transferred eggs only.

No maternal effects were observed. As scored by eye colour at birth, young from homozygous non-brown transferred eggs developed black eyes in a maternal environment homozygous for brown and pink eye; eyes which were homozygous brown developed normally in a homozygous non-brown host. In these cases, the transferred eggs and the host were all homozygous for non-agouti. In young scored a fortnight after birth, homozygous Rex and homozygous albino both showed normal expression after gestation in a host homozygous for absence of Rex and albino.

The ages of transferred eggs and recipient females were timed from the formation of a vaginal plug, with an absolute error of plus or minus a $\frac{1}{4}$-day, and the developmental stage of each egg was noted. Transplantation of fifty-five morulæ and blastulæ into recipients the sexual state of which was out of phase with the age of the eggs by a day or more, and transplantation of forty-four 1- and 2-cell stages, were unsuccessful. The five successes achieved were with morulæ and blastulæ transferred into recipients of almost exactly the appropriate sexual stage, as shown in the accompanying table. Similar optimal conditions for transfer had already been found by Fekete and Little[3], using an operative technique.

Transference of Mouse Morulæ and Blastulæ into Recipient Females of Similar Age from Copulation

Data concerning females which failed to produce any young at all are excluded. In each successful inovulation, one transferred egg per recipient female was recovered in the resulting litter

Age from copulation (days)		No. of recipient females	No. of eggs transferred	No. of transferred eggs recovered as young
Transferred eggs	Recipient females			
$2\frac{1}{4}$	2	1	5	0
$2\frac{1}{2}$	$2\frac{1}{4}$	2	8	1
3	$3\frac{1}{4}$	1	4	1
$3\frac{1}{4}$	3	1	6	1
$3\frac{1}{2}$	$3\frac{1}{4}$	8	36	2

The present results show that eggs transferred by inovulation can come to term, but further work is necessary to establish whether the technique can develop into a routine method for egg transference.

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An Electrophoresis Apparatus for analysing Several Sera Simultaneously

A systematic study, such as we contemplate, on the influence of disease on the electrophoresis pattern of serum, requires observations on large numbers of sera. Such an investigation is laborious and time-consuming when the available techniques and apparatus are utilized, because only a very limited number of experiments can be completed in one day. We have, therefore, devised a method whereby two electrophoretic analyses can be made simultaneously using the Tiselius apparatus with a standard central section.

The apparatus is illustrated in Fig. 1. The electrode vessels are connected on to 'Perspex' adaptors (*A* and *B*) and the standard central section of the electrophoresis cell held between them. Prior to assembly, the ground surfaces of the 'Perspex' adaptors as well as those of the electrode cell are well greased, and thin 'Cellophane' membranes are then clamped between the sections in the position indicated (M_1 and M_2). The protein solutions to be analysed are held between the membranes, and the rest of the apparatus filled with buffer and saturated potassium chloride in the usual way. The dimensions of the adaptors are such that they fit the Hilger electrophoresis bath and cell holder.

A *p*H for electrophoresis must be selected where all the components present migrate towards the bottom membrane. In the case of serum, this is achieved at *p*H values above neutrality.

In Fig. 2 are shown electrophoresis diagrams of two samples of the same bovine serum obtained simultaneously using the two limbs of the standard electrophoresis cell. On inspection of the diagrams it will be noticed that they are identical. The reason for the markedly enhanced δ-effect visible at the beginning of the electrophoresis diagram is, as yet, unexplained. In the diagram of the same serum obtained with the standard apparatus, the δ-effect was small.

Electrosmotic effects do exist; but apparently they have no effect on the electrophoresis diagram. Mobility measurements calculated from electrophoresis diagrams obtained in the modified apparatus described are likely to be effected by the electrosmotic effects, but the samples studied simultaneously are comparable.

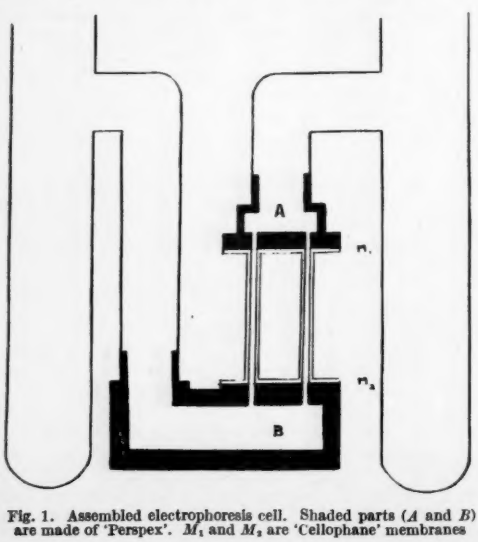

Fig. 1. Assembled electrophoresis cell. Shaded parts (*A* and *B*) are made of 'Perspex'. M_1 and M_2 are 'Cellophane' membranes

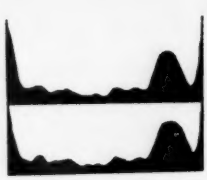

Fig. 2

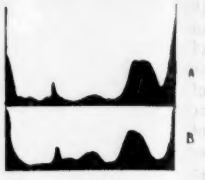

Fig. 3

Fig. 2. Electrophoresis diagrams of two samples of the same bovine serum obtained simultaneously

Fig. 3. Electrophoresis diagrams of normal serum (*A*) and serum from a chronic nephritic (*B*). They were obtained simultaneously by the use of the modified cell

The technique described points the way to a means of mass electrophoresis of sera, as there is no theoretical limit to the number of compartments which can be built into the analytical section of the cell.

A further advantage of this type of cell is that exact comparisons can be made between sera obtained from different sources. This advantage is clearly brought out in Fig. 3, which shows the difference between the serum from a normal and a chronic nephritic subject. The nephritic serum albumin has a mobility slightly less than that of the normal albumin. The α-globulin has the same mobility in both sera, and the β-globulin in the normal serum has, in turn, a lower migration-rate than the corresponding globulin in nephritic serum.

This investigation was assisted by grants from the Council for Scientific and Industrial Research and the Nkane Kitwe Poliomyelitis Research Fund.

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Isolation of a Crystalline Disaccharide, Hyalobiuronic Acid, from Hyaluronic Acid

The structure of hyaluronic acid, an important constituent of the 'ground substance', has been the subject of intensive study in recent years. Applications of conventional methylation and periodate consumption methods to the intact polysaccharide[1,2] have indicated that such methods will not yield substantial evidence of structure. The isolation and clarification of structure of crystalline oligosaccharides derived from hyaluronic acid is the most rigorous method of studying the structural details of this physiologically important substance. Such well-defined compounds are also required as models for establishing the specificity of the enzyme systems acting on hyaluronic acid.

The present communication is concerned with the isolation and characterization of a crystalline aldobiuronic acid from sodium hyaluronate in relatively high yield, following degradation by a combination of enzymic and mild acid hydrolysis. Sodium hyaluronate (analysis[3]: nitrogen, 3·78; uronic acid, 44·0; hexosamine, 38·8; sulphate, less than 0·5) was hydrolysed with purified testicular hyaluronidase

(600 turbidity reducing units per mgm.) until the increase in reducing sugar[4] was equal to 0·35 mgm. of glucose equivalent per mgm. of substrate. The small precipitate obtained on addition of two volumes of ethanol was removed, and the filtrate was then concentrated *in vacuo* to remove the ethanol. Addition of 4 volumes of absolute ethanol resulted in separation of a syrup, which was hardened with ethanol. The colourless, amorphous product was dried over calcium chloride and gave the following analysis: nitrogen, 2·81; uronic acid, 39·7; hexosamine, 37·9; reducing sugar (as glucose), 30·9. The yield from 1·91 gm. of sodium hyaluronate was 1·84 gm. A solution of 1·00 gm. of this product in 20 ml. of 1·0 *N* sulphuric acid was heated for 3 hr. at 99° in a sealed tube, then cooled and neutralized to *p*H 5·0 with saturated barium hydroxide. After removal of the precipitate, the amber solution was concentrated to 7 ml. and chilled, whereupon 300 mgm. of colourless material, appearing as rectangular, long prisms under the microscope, was deposited. Reheating the filtrate and washings with sulphuric acid, followed by neutralization and concentration, yielded an additional 130 mgm. Reprecipitation from 0·2 *N* hydrochloric acid solution with 1·0 *N* sodium carbonate gave homogeneous, long, rectangular prisms, weighing 232 mgm. after drying *in vacuo* over calcium chloride. The analysis of this material is presented in the accompanying table, with the values calculated for a disaccharide containing one residue of glucosamine and one of glucuronic acid.

ANALYSIS OF HYALOBIURONIC ACID

	Calc. for $C_{13}H_{21}O_{11}N$	Found
Carbon	40·56	40·01
Hydrogen	5·96	6·02
Nitrogen (Dumas)	3·94	3·99
Amino nitrogen (van Slyke)	3·94	3·96
Hexosamine	50·5	49·0
Uronic acid (gasometric)	55·2	54·3
Reducing sugar, ferricyanide[4]		68·0
Reducing sugar, hypoiodite[5]		61·0
$[\alpha, 24°, D]$ (2·60 per cent in 0·10 *N* hydrochloric acid)		+31°

Potentiometric titration indicated a substance with a pK_1' of 2·6 and a pK_2' of 7·1. On a micro hot-stage, the substance slowly decomposed without melting, beginning to darken at about 200°. The material was insoluble in glacial acetic acid, ethanol, methanol and pyridine, and almost insoluble in water. It was sparingly soluble in hot water, dilute hydrochloric acid, and dilute sodium bicarbonate. On a paper chromatogram developed by the ascending method with butanol – acetic acid – water (38 : 12 : 50) and then sprayed with *p*-dimethylaminobenzaldehyde, the material migrated with an R_F of 0·13, compared with 0·29 for glucosamine, and 0·43 for N-acetylglucosamine. The colour was identical with that given by glucosamine. The direct Elson–Morgan reaction (without preliminary hydrolysis) gave a colour value equivalent to 29 per cent of glucosamine by weight. The glucosamine residue, therefore, has a colour yield in this reaction which is only about 60 per cent of that of free glucosamine on a molar basis.

Despite the constancy of the chemical properties of all fractions examined in the course of these experiments, and the homogeneity with respect to crystal habit of the fraction described here, the analysis of this fraction by a solubility method gave results not consistent with the presence of a single species. This observation may be the result of an artefact of the analytical method, or of physical or chemical transformations which frequently occur with carbohydrate compounds. On the other hand, it may reflect the presence of two species with a structural difference due to the structure of the original polysaccharide. Further study will be required to clarify this point.

In any event, the isolated material, for which we propose the name 'hyalobiuronic acid', has the structure of a glucuronido–glucosamine with the free reducing group in the glucosamine residue. The insolubility in water must be attributed in part to the existence of the material in zwitterionic form. The stability to acid hydrolysis indicates that the glucuronic acid residue is present as a pyranoside. It is perhaps worth while to point out that hyalobiuronic acid will require re-acetylation of its amino group before a model can be obtained which will be suitable for comparison with the products obtained by enzymic hydrolysis of hyaluronic acid.

This investigation was supported by a grant from the Helen Hay Whitney Foundation.

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A Brown Discoloration of Pig Fat and Vitamin E Deficiency

THE consumption of vitamin E-deficient diets rich in highly unsaturated fatty acids, by chicks and by rats, is followed by the appearance of a yellow-brown coloration of the adipose tissue[1,2]. This pigmentation can be prevented by feeding a supplement of α-tocopherol acetate[3].

In an experiment carried out at the Agricultural Research Institute (N.I.), six female pigs were given a vitamin E-deficient diet containing 5 per cent dried skim milk powder, 5 per cent dried yeast, 5 per cent white fish meal, 5 per cent liver meal, 15 per cent palm kernel meal (ext.) and 65 per cent cassava meal, with a mineral supplement of salt and limestone; the vitamin E content was less than 0·1 mgm./100 gm. In addition, two of the pigs (group *A*) received 1 oz. cod-liver oil, as a vitamin supplement, once per week from weaning until they reached 100 lb. liveweight, two pigs (group *B*) received cod-liver oil throughout, at the rate of 5 per cent of their meal ration, while the remaining pigs (group *C*) received cod-liver oil at the 5 per cent level, together with 50 mgm. *dl*-α-tocopherol acetate a head each day. The meal was fed individually to all pigs, as a wet mash, on a slightly restricted scale of feeding[4]; in groups *B* and *C* the cod-liver oil was added directly to each morning feed, and in group *C* the tocopherol

acetate was added as pellets to the afternoon feed. The animals, which had been reared normally until weaning at about 30 lb. live-weight, were then all placed on the control diet; the full experimental feeding commenced at 50 lb. weight. They made satisfactory growth and exhibited no unusual external symptoms up to the time of slaughter at 210 lb. weight, after an experimental period of 120 days.

After slaughter at a bacon factory, the carcases were commercially graded, and samples of fat removed for analyses. The back-fats of group *B* were deep yellow-brown in colour and with a slightly 'oxidized' odour; the carcases were condemned as unfit for curing. The back-fats of the remaining pigs were normal in appearance and the carcases were passed through all stages of curing.

The average peroxide values[5] of whole samples of extracted loin back-fat from groups *A*, *B* and *C* were 0, 5 and 0 respectively, while the induction periods[6] were 72, 12 and 17 and the iodine values 57, 74 and 80. Determinations of vitamin E[7] gave figures of 3·0, 0 and 2·8 mgm./100 gm. Examination of the brown pigment in the fat samples from group *B* suggests that it is similar to that described by Dam and Granados[3] in connexion with vitamin E-deficient rats and chicks. Moreover, there is reason to believe that it is also related to the discoloration of carcases occasionally encountered commercially when pigs have been fed diets containing high levels of fish oils.

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Cholinesterase Inhibition by Parathion *in vivo*

We have shown[1] that OO-diethyl-O-*p*-nitrophenyl thiophosphate, an insecticidal compound generally known as parathion or *E*605, has not, when pure, any measurable *in vitro* inhibition of rat's brain cholinesterase. Nevertheless, pure parathion is a powerful inhibitor of cholinesterase *in vivo*, and there is little doubt that its mammalian toxicity is due to this property. When parathion is administered intraperitoneally to male rats (180–220 gm.) the dose necessary to produce a 50 per cent inhibition of brain cholinesterase within 30 min. is about 1·5 mgm./kgm., a figure of the same order as that required for OS-diethyl-O-*p*-nitrophenyl thiophosphate, the S-ethyl isomer of parathion, which is a highly active *in vitro* inhibitor[1]. With a dose of 3 mgm./kgm. the onset of the typical symptoms of parasympathetic stimulation occurs within 10 min. with both compounds. The cholinesterase activity of rat's blood, which is mainly due to specific enzyme in the red cells, is also unaffected by parathion *in vitro*; but *in vivo* it can readily be completely inhibited by injected parathion. There is, however, a slight but significant difference between the action of parathion and its S-ethyl isomer *in vivo*; when a dose of the former, which produces complete inhibition, is administered intravenously, there is a lag of a few minutes before the inhibition develops, whereas with the same dose of the latter the inhibition reaches completion very rapidly after injection.

These observations lead to the hypothesis that parathion undergoes a change to an active inhibitor after injection, and in confirmation of this it has been found that rat's blood may readily be inhibited by parathion *in vitro* in the presence of liver slices or homogenate. For example, 5 ml. heparinized whole blood was incubated at 37° C. with 2·5 gm. liver slices and 0·0056 ml. parathion solution (1·5 per cent in ethanol), added by means of a micrometer syringe; the cholinesterase activity of the blood was completely inhibited within 10 min. The presumed metabolite must be very unstable in blood, for if inhibited blood is withdrawn from a dosed animal it is not capable of inhibiting further cholinesterase added to it, nor does partly inhibited blood undergo a decrease in activity when incubated *in vitro*.

The inference from this investigation is that parathion administered to a rat is rapidly converted by the liver to an unstable cholinesterase inhibitor. Experiments previously performed in this Laboratory on hepatectomized rats by Dr. M. W. Goldblatt and Mr. J. Frodsham have indicated that the liver cannot be the sole site of such a presumed metabolic change, for when it has been removed a rat is not less sensitive to parathion. Moreover, the miotic effect observed when parathion is instilled into a rabbit's eye suggests that an active cholinesterase inhibitor is produced in the region of that organ. Experiments at present in progress with muscle and other tissues have not so far yielded positive results.

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'Double-Action' of Trichothecin and its Production in Soil

Trichothecin was the name given by Freeman and Morrison[1] to a stable antifungal agent produced by *Trichothecium roseum*. They report the ability of this antibiotic to withstand boiling, and it has been found here that its activity is unaffected by autoclaving for 1 hr. at 20 lb./sq. in. pressure on three successive occasions. This marked thermostability and the neutral reaction of trichothecin have prompted its use in this laboratory for studies on antibiotic production in the soil; *Fusarium oxysporum* var. *cubense* was the test fungus used and the lethal dose 90 was adopted as the activity unit.

A technique was devised for the study of the effect of an antibiotic on mycelial growth as apart from the effect on spore germination and subsequent growth. A standard amount of the test fungus (mycelium on agar) was placed at the centres of a series of plates,

each containing 10 ml. of the Freeman and Morrison[1] medium solidified with agar. After incubating for 48 hr. at 25° C., the diameters of the colonies were measured and to the nutrient agar surface was added 5 ml. of the antibiotic solution, each plate being rotated so that the solution formed a liquid film over the surface. The test plates and appropriate controls were then incubated for a further 18 hr. and the diameters remeasured. The interesting result here was that when exceedingly small concentrations of trichothecin (0·00018–0·0018 units/ml.) were used there was a well-marked stimulation of growth. In higher concentrations (0·0018–10 units/ml.) the effect was fungistatic. Above these amounts there was a killing effect, and with 44 units/ml. the effect was wholly fungicidal.

A 'double-action' of long-chain unsaturated fatty acids on some bacteria has been reported[2,3]. When the concentration of trichothecin used was more than 10 units/ml., a pronounced swelling of the hyphal tips was noted, together with a bursting of some of these tips. The surface activity of the antibiotic is indicated by its reducing effect on surface tension.

It is suggested that trichothecin accelerates the bond-break phase of growth. In very minute amounts, trichothecin stimulates growth by slightly accelerating bond-break, enough to allow increased elongation but not enough to result in molecular disorganization. It is thought that it is this disorganization of the molecular make-up of the wall that in higher concentrations is responsible for the inhibition of growth and in still higher concentrations for the swelling and bursting of the tip.

In my experience, there is no report in the literature of a demonstration of the production of an antibiotic in sterile but otherwise untreated soil as well as in artificial media. This point was emphasized more than once at the seventh International Botanical Congress at Stockholm[4]. The following method has provided a positive demonstration of the production in sterile soil of trichothecin by *Trichothecium roseum*.

A sample of sterile garden soil (*p*H 6) was inoculated with *T. roseum* and incubated at 25° C. for ten days. Shallow layers of this soil-culture were added to a series of Petri dishes and triple autoclaved together with dishes containing sterile soil as controls. After autoclaving, 10 ml. of Freeman and Morrison agar was poured into each plate in order to anchor the soil layer. An extra 20 ml. was then added to form a smooth-surfaced layer in which the soil was embedded. These plates were left for 20 hr. to allow diffusion into the medium of any antibiotic produced by the growth of the fungus. A standard amount of the test fungus was then placed at the centre of each plate, the plates being incubated at 25° C. for four days. In each case there was a 9·6 per cent reduction in the diameter of the test fungus colony over the soil where *T. roseum* had been grown as compared with growth over sterile soil. After 18 days growth in the soil, a 10·9 per cent reduction in linear growth was recorded.

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The Fermentation-inhibiting Properties of Orange Oil

The recent communication by Zukerman[1] leads us to give a preliminary note on our investigations on the antimicrobial properties of orange oil.

The starting point in these investigations was the observation that non-preserved fruit drinks, prepared from emulsified orange oil, inhibited the fermentation at 25° C. of an inoculum of 10^4 cells/ml. *Saccharomyces cerevisiæ*[2].

Experiments were carried out with a semi-synthetic medium, containing 10 per cent sucrose and 0·25 per cent yeast autolysate ('Difco') at $p\mathrm{H} = 5{\cdot}3 \pm 0{\cdot}2$. Florida orange oil (aldehydes, calculated as decylaldehyde = 1·6 per cent) was added in alcoholic solution to a final concentration of 1 per cent v/v of alcohol. It appeared that 0·01 or more per cent of oil could retard the fermentation of the medium by the inoculum referred to in such a way as increasing the time required for complete fermentation (in blank experiments, 48 hr. or less) to at least 96 hr.

Since Guenther[3] claims that the antimicrobial properties of essential oils such as orange oil are due to the terpenes rather than to the fraction containing oxygen derivatives, a Guinea orange oil (aldehydes = 1·7 per cent) and both the terpenes and the oxygen compounds (3·6 per cent) derived from it by 'Duosol' extraction with 90 per cent methanol/pentane[4] were studied. This investigation revealed that the terpenes possessed the same order of fermentation-inhibiting activity as the oil, whereas the oxygen fraction was inactive in concentrations occurring in additions of orange oil of the order of 0·1 per cent.

During the experiments the terpenes were stored in the refrigerator. They showed $[n]D^{20} = 1{\cdot}4726$ and a peroxide value of 6·8 m.eq. oxygen/kgm.

Research along these lines is being continued.

I am greatly indebted to Messrs. N.V. Chemische Fabriek "Naarden", Naarden, Netherlands, for their very helpful co-operation in procuring the essential oils and oil fractions used in this investigation.

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Chlorosaccus ulvaceus Messik. and Vischer

Between April and October of this year, a rare member of the Xanthophyceæ, *Chlorosaccus*[1], a genus not previously recorded in the British Isles, has been collected on eight different occasions in east Yorkshire. It occurs in two much-shaded streams, one of them near South Cave, the other at Cottingham. From the former locality *Chlorosaccus* has now disappeared and in the latter it is extremely rare.

The pale yellow-green palmelloid colonies become macroscopic, irregular in shape and reach several centimetres in length; they are free-floating or entangled in submerged twigs. Actively swimming zoospores were obtained from material collected in June, July, September and (in smaller numbers) in

October. A full account of the species will be published elsewhere.

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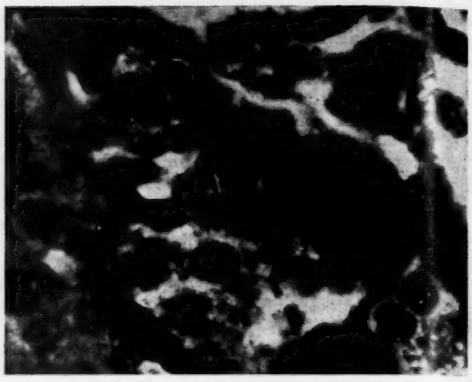
Fluorochromy as an Aid in the Resolution of the Specific Granules of the Islets of Langerhans

Visualization of individual granules in beta-cells of the islets of Langerhans is particularly difficult in many species, including man. Aside from electron microscopy, few techniques provide sufficient resolution to detect variations in the size or shape of individual granules owing to their minute size. Phase microscopy of stained specimens has proved satisfactory for observing extreme deviations from the normal[1]; but variations of less magnitude are difficult to assess. Strongly fluorescent granules illuminated by long ultra-violet rays (λ 300–400 mμ) act as self-luminous sources of visible light located within the specimen, and this permits use of the maximum aperture of apochromatic oil-immersion objectives. As the autofluorescence of islet cell granules is weak[2], their fluorescence must be intensified for adequate results. Various fluorochrome dyes were tried for this purpose and some yielded results which appear definitely superior to those obtained by either conventional or phase microscopy. The methods evolved are briefly outlined here, as most reports concerning fluorescence microscopy of the pancreas[3–4] make little reference to the use of fluorochrome dyes.

Paraffin sections (3 μ) of Bouin-fixed pancreatic tissue obtained from normal Wistar albino rats were washed in tap water until all visible traces of yellow were removed. Thorough washing is necessary in order to remove picric salts, for if these remain in the sections fluorescence is quenched. A number of fluorochrome dyes were tried, including primuline, thioflavine *S*, acridine yellow (*H* 107), acriflavine, coriphosphine, auramine *O* (all obtained from Edward Gurr, Ltd., London) and rhodamine *B* (749, Hopkin and Williams, Ltd., London). Sections were immersed for 2–4 min. in filtrates of saturated aqueous solutions of the various dyes, either alone or in combination. After a brief rinse in tap water, slides were blotted, rapidly dehydrated by a few dips in absolute ethyl alcohol, and cleared in xylol. Preliminary trials with a variety of mounting media indicated that the greater the difference between the refractive index of the granules and that of the mounting media the more intense the fluorescence. Xylol was found very satisfactory for temporary mounts (refractive index 1·494). The light source was a 250-watt high-pressure mercury lamp (British Thomson-Houston) with all appreciable visible light removed by a thick (5 mm.) filter of Wood's glass. A quartz reflecting prism and a quartz condenser were employed, although others of glass will serve almost as well. A Cooke apochromatic oil-immersion objective (N.A. 1·32) was used in combination with a 10 × ocular and a green glass eyepiece filter to eliminate the ultra-violet background. Shillaber's immersion oil was employed because of its low fluorescence.

The best results were obtained with sections stained with acriflavine, although those treated with either primuline or thioflavine *S* were almost equally satisfactory. These imparted an intense (yellowish) fluorescence to the granules in islet cells, as illustrated in the accompanying photomicrograph. After initial treatment with any of these fluorochromes, if the sections are counterstained with rhodamine *B*, the islets are sharply differentiated from surrounding acinar cells, for the latter emit a strong orange fluorescence from their basal portions. Tinctorial differentiation of alpha- and beta-cells was not achieved with any of the fluorescent dyes tried; but characteristics of individual granules are so clearly resolved that cell-types may be identified by the size and number of their granules. In these sections, the granules appear larger than when stained by more conventional methods. Adsorption of dye on the surface of the granule may be responsible, at least in part, for this phenomenon. Alpha-cells appear brighter than beta-cells, for granules in the former are more numerous and closely packed. Beta-cell granules can be so clearly resolved that it is quite possible to observe distinctly their individual size and shape in many instances. This should prove of distinct value in studies of the experimental histology and pathology of the islets of Langerhans.



Pancreas stained with acriflavine illuminated by long ultra-violet rays. Details of fixation and staining are given in text. The unstained nuclei appear as oval black areas. The granules in both acinar and islet cells appear white against a black background. Acinar granules can be seen in the lower right corner. Cytoplasm of an alpha-cell just to the left of this appears almost entirely white, for its granules are crowded closely together. The remainder of the islet, which nearly fills the entire field, is made up of beta-cells. Their granules appear as small white bodies. Final magnification, 1,100 ×

The possibilities of fluorochromy as an aid in visualization of the details of very small structures do not seem to have been fully explored. It is possible that applications of this technique to other organs might be of assistance to cytologists in resolving minute bodies.

The techniques described were developed in the Department of Human Anatomy, University Museum, Oxford, during study leave from the University of Toronto. Thanks are due to Dr. Robert Barer for providing facilities and for his continuous advice and encouragement.

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Sept. 1.

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Adaptation in Rodent Moles and Insectivorous Moles, and the Theory of Convergence

STUDIES in connexion with the life-history of the Orange Free State rodent mole, *Cryptomys*, brought to light a remarkable degree of adaptation, anatomically and psychologically, to its mode of life in total darkness.

The most interesting expression of psychological adaptation is observed with regard to the animal's power of orientation, keeping in mind the fact that it is totally blind. Damage to its tunnels may be caused by several factors, the most important of which are large and small Ungulates, rain, dogs and man. The tunnels are bored only a few inches below the surface. In this manner, tunnel damage may be a daily occurrence where cattle and horses are grazing. A tunnel may be damaged to such an extent that, for fairly long distances, it cannot be used. However, where such damage occurs in connexion with mole systems, proper connexion between even widely separated undisturbed tunnel sections is effected in a remarkably short time and correct manner, while at the same time the mole displays highly developed powers of orientation. No matter how severely damaged these tunnels may be, either cutting off the moles in the veldt from the nest or *vice versa*, these animals reach their goal unfailingly without trial or error.

Experiments and observations confirmed this interesting power of orientation, a more detailed discussion of which has already been published[1].

Briefly, the experiments were conducted as follows: (*a*) In one set of experiments a tunnel was opened up for a certain distance, for example, fifty feet from its terminal portion in the veldt; (*b*) in another set of experiments the tunnel was opened up between nest and veldt terminus; (*c*) in still another set of experiments the tunnels radiating from the nest were opened up all around the nest for some distance veldtwards.

In (*a*) the mole plugged the mouth of the undisturbed portion of the tunnel and started to bore another one parallel to the one destroyed, ultimately reaching the veldt terminal spot again. This process of boring parallel to destroyed tunnels has been observed to be repeated as many as twelve times.

In (*b*) the mole, after plugging the one opening, bored another tunnel parallel to the portion opened up, connecting up correctly with the remaining intact portion, the opening of which was then also plugged. As in (*a*), the process may be repeated.

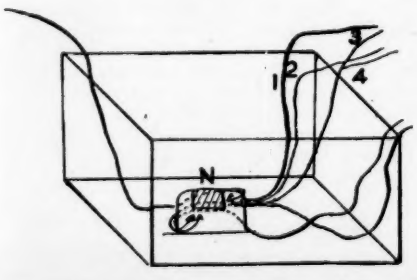

Fig. 1. Tunnels 1, 2, 3, 4 bored consecutively after opening up previous one; thus tunnel 2 is bored after tunnel 1 is opened up. *N*, nest

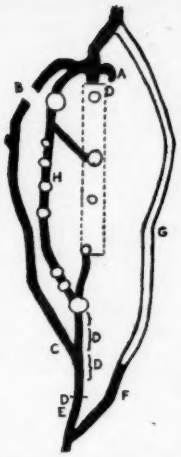

Fig. 2. Orientation in *Bathyergus maritimus*. *A*, Feb. 10, 1951; *H*, tunnel bored Feb. 10; *C*, Feb. 12; *F*, new tunnel bored Feb. 12; *B*, gap of 1¼ ft. between two approaching tunnels not completely connected; *D*, tunnel plugged here when opened up on Feb. 13; *E*, tunnel opened up on Feb. 13; *G*, old, plugged-up tunnel repaired and taken into use again

In (*c*) the moles bored nestward, reaching their destination without trial or error (Fig. 1). Here, too, the experiment may be repeated with the same result.

Consequent to these observations on the mole rat *Cryptomys*, observations were also made on three other rodent mole species, including the large dune mole *Bathyergus maritimus*. They all showed the same ability of orientation as *Cryptomys*.

Bathyergus maritimus, for example, is the largest rodent mole of South Africa and inhabits the sandy sea-shores, six hundred or more miles away from the habitat of *Cryptomys*, which inhabits the dry Free State veldt. Its tunnels are dug by means of strongly developed front claws, whereas *Cryptomys* bores by means of its lower incisors, which in contrast to those of *Bathyergus* are separately movable as no ossification takes place at the mandibular symphysis. Thus other differences obtain. However, both species are blind and subterranean. Experiments of type (*b*) described above yielded the same results with regard to *Bathyergus maritimus* (Fig. 2).

Similar observations on the Cape Golden mole, which belongs to the order Insectivora, showed that, so far as orientation is concerned, the two different orders display a high degree of biological convergence, as in fact the absence of visual sense, absence of external ear pinnæ, reduced tail, strong front- and hind-quarter musculature and other anatomical homologies, express the phenomenon of convergence associated with similar mode of living.

An interesting question arises as to which sensory organ or organs make this orientation possible.

Thanks to the fact that the mole rat is easily bred in glass cages containing damp soil, modes of behaviour could be recorded which otherwise might escape observation. By means of apparatus adapted to the mole, we are studying its sense organs, learning ability and reactions. We were greatly struck by the strong and quick reactions (40 σ) to air currents, vibration and sounds. It seems as if the explanation of the orientation behaviour must be looked for in a combination of these senses.

I am grateful to the Council for Scientific and Industrial Research and to Prof. Immelman and Mr. Brits, of the Department of Physics, for technical aid.

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A Quantum Mechanical Study of Lithium Hydride

The electronic energy of lithium hydride has been computed by the Hartree–Fock approximation. The computations were carried out both by the linear combination of atomic orbitals approximation according to the molecular orbital method, and by the electron-pair approximation according to Heitler and London with inclusion of ionic terms. When only the two valence electrons were considered, the computed values of the binding energy were as follows:

Linear combination of atomic orbitals approximation of molecular orbitals	3·57 eV.
Electron-pair method without ionic terms	2·64 „
Electron-pair method with ionic terms	3·68 „
Experimental value[1]	2·54 ± 0·2 eV.

In these computations the value of the interatomic distance, R, was put equal to the experimental value, 1·6 A. As the computed energy values are larger than the experimental value, the neglect of the repulsion between the valence electrons and the electrons in the inner shell of the lithium atom seems to cause a considerable error. This fact is in agreement with the result of James's calculations[2] on the lithium molecule (Li_2). Therefore the energy of the lithium hydride molecule was computed with a wave function including molecular orbitals for all the four electrons of the molecule. This more accurate treatment resulted in a computed value of the binding energy of 2·0 eV. when $R = 1{\cdot}6$ A. The computations will be repeated with other values of this parameter. It seems reasonable to expect that these new computations will result in energy values not much different from the one computed already.

Although the value of the binding energy is evidently rather sensitive to the method of approximation, it may be hoped that the form obtained for the wave function and thus the electron distribution is more insensitive. Both in the two-electron cases and in the four-electron case, the best values of the parameters in the wave function indicate that the structure Li^+H^- is the most important one. This fact emphasizes that no significance should be attributed to the apparently excellent agreement between the experimental value of the binding energy and that computed according to the electron-pair method without ionic terms. The same objection is applicable to the calculations on lithium hydride by Hutchisson and Muskat[3]. The calculated structure Li^+H^- is in good agreement with the experimental fact that hydrogen is obtained at the anode during electrolysis of lithium hydride.

Another interesting point in the results of the calculations is the relative importance of 2*s*- and 2*p*-orbitals around the lithium atom, that is, the degree of '*s*,*p*-hybridization'. If this degree of hybridization is calculated according to the criterion of maximum overlapping, the *s*- and *p*-orbitals are found to be of about equal importance. Almost the same result is obtained when only the two valence electrons are considered in the calculations of the energy. However, when the molecular orbitals of all the four electrons are included in the wave function, the 2*p*-orbital is found to be much less important than the 2*s*-orbital. This result seems to be reasonable, as the 2*p*-energy-level of the free lithium atom lies as much as 1·85 eV. above the ground-level.

Full details of this investigation will be published elsewhere.

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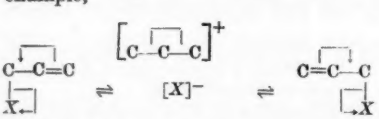
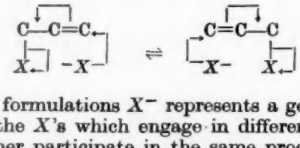
Demonstration of Bimolecular Anionotropic Change

Though it has long been accepted that the unimolecular process S_N1' represents a common mechanism of isomeric rearrangement and of substitution with rearrangement in anionotropic systems, for example,



(S_N1')

the idea has been extant since 1938[1] that a bimolecular mode of rearrangement S_N2' might also exist:

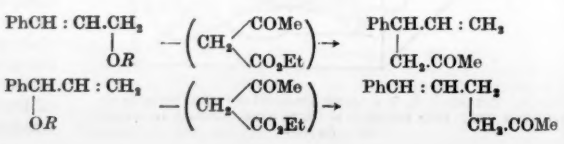


(S_N2')

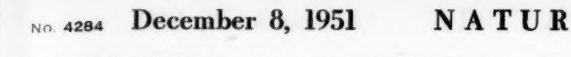
In these formulations X^- represents a general anion, so that the X's which engage in different processes, or together participate in the same process, may, or may not, be chemically identical.

The earlier attempts[2] to detect mechanism S_N2' resulted (*a*) in producing new evidence substantiating the mechanism S_N1', and (*b*) in showing that, under conditions leading only to bimolecular reactions, any bimolecular substitution with rearrangement S_N2' was so relatively unimportant as to be masked by bimolecular substitution without rearrangement S_N2 in the systems studied.

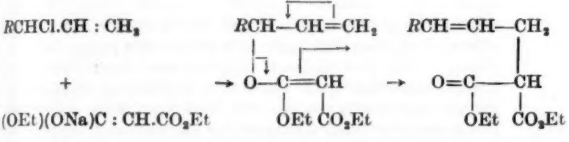
There is, however, one group of cases in which evidence for bimolecular rearrangement S_N2' has been claimed. They are all of one type: the entering substituent comes from a pseudo-acid. By treatment with ethyl acetoacetate and a basic catalyst, cinnamyl alcohol has been converted, probably through its esters, to 1-phenylallylacetone, and 1-phenylallyl alcohol has been similarly converted to cinnamylacetone[3]:



1-Methylallyl chloride has been converted by treatment with ethyl sodiomalonate partly into the normal substitution product, but partly also into the rearranged product, ethyl crotylmalonate; and 1-ethylallyl chloride has been found to undergo similar reactions[4a]:



However, as Dewar has pointed out[5], the difficulty about accepting such demonstrations of the S_N2' mechanism is that a pseudo-acid always has at least two reactive centres, so that the observed result could arise from a normal S_N2 substitution followed by a Claisen rearrangement (that is, the known intramolecular allyl transformation, as of phenyl allyl ether to *o*-allylphenol):



The formation of rearranged products has also been observed in the reactions of amines with allylic halides; but a careful scrutiny of the changes showed that no unambiguous evidence for the simple S_N2' mechanism could be derived from the results[4b].

As suggested previously, the difficulty about establishing mechanism S_N2' is, not that it does not exist, but that mechanism S_N2 is usually fast enough to mask it. Such masking can be avoided by the following method[6]. The allyl compound, for example, 1-methylallyl bromide, is allowed to interact, under conditions leading only to bimolecular substitution, with a supplied anion, for example, radiobromide ion, identical but for an isotopic distinction with the anion that could be given by the allyl compound. This secures that every individual molecular act of substitution by mechanism S_N2 will, for all ordinary chemical purposes, replace the original molecule by an identical one; so that the original substance never becomes used up by mechanism S_N2, but continues to be available indefinitely for the observation, at any necessary temperature, of isomerization by mechanism S_N2'. The kinetics of the latter reaction can be controlled, and its rate determined, by ordinary chemical means; and this S_N2' rate can be compared with the rate of the S_N2 exchange, which is also kinetically controlled, as determined by radiochemical means. This programme has been carried through for the bimolecular reactions of both 1-methylallyl bromide and crotyl bromide with lithium bromide in acetone. The kinetic data[7] are in the accompanying table: they furnish what at present is the only indubitable demonstration of the S_N2' mechanism.

RATE CONSTANTS AND ARRHENIUS PARAMETERS OF BIMOLECULAR BROMINE EXCHANGE (S_N2) AND BIMOLECULAR ISOMERIZATION (S_N2') OF ALLYL BROMIDES WITH LITHIUM BROMIDE IN ACETONE (k_2 and A_2 in sec^{-1}. mole^{-1} l., and E_A in kcal. mole.$^{-1}$)

Bromide	Reaction	$10^6\ k_2$ (25°)	$\log_{10}A_2$	E_A
1-Methylallyl	S_N2	879	9·06	16·5
	S_N2'	14·9	9·40	19·4
Crotyl	S_N2	141,000	9·93	14·7
	S_N2'	5	~9	~19

It will be seen that both halides undergo both bimolecular reactions. But for 1-methylallyl bromide, the S_N2 reaction goes 60 times faster than the S_N2' process, while for crotyl bromide the S_N2 exchange proceeds 28,000 times faster than the S_N2' isomerizations. It is easy to understand why the S_N2' mechanism is difficult to observe when a concomitant S_N2 substitution can mask it. However, it is also clear that the difference in the two rate-ratios, S_N2/S_N2', arises mainly from the difference between the two S_N2 rates. Thus it is probable that the great drop in the ratio from 28,000 to 60 is largely a local effect of the 1-methyl substituent in repressing the local S_N2 reaction; and this supports an earlier suggestion[8] that S_N2' rearrangements should be sought in the reactions of 1-*tert.*-butylallyl halides, a task which we now have in hand. The generally reduced rates of the S_N2' as compared with the S_N2 reactions have been ascribed[9] to the circumstance that in the former the reagent attacks a nucleus of unsaturated carbon, which is protected by the double π-electron layer, while in the latter it attacks a nucleus of saturated carbon, which has no such protection. (The π-electrons of C=C will be displaced somewhat towards the group CH_2Br: otherwise the S_N2' reactions would be slower still.)

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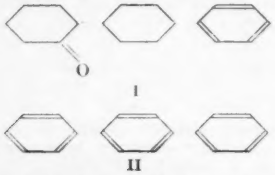
A New Synthesis of *p*-Terphenyl and its Derivatives

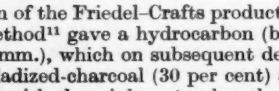
WHEN unsaturated ketones in cyclic systems are subjected to Friedel–Crafts reaction[1] in presence of anhydrous aluminium chloride, they give rise to unexpected products. Some significant observations have been made in this laboratory[2] on the Friedel–Crafts reaction involving unsaturated ketones, and this reaction, when extended to *cyclo*hexenyl–*cyclo*hexanone, led to a new method of synthesis of *p*-terphenyl and its derivatives. Although a number of such syntheses have been described in the literature[3–7], the present method offers a more convenient synthesis of *p*-terphenyl and its derivatives starting from easily available materials. Moreover, studies on the condensation of *cyclo*hexenyl–*cyclo*hexanone with biphenyl, *p*-terphenyl, etc., are in progress, which may eventually lead to the development of a new general method for synthesis of polyphenyls.

*Cyclo*hexenyl–*cyclo*hexanone, prepared according to the method of Wallach[8], was condensed with benzene in presence of anhydrous aluminium chloride to give the

ketone (I, boiling point 185–190°/2 mm. in 85 per cent yield; semicarbazone, crystallized from ethanol, melting point 227–228°). The ketone I was dehydrogenated by heating with palladized-charcoal (30 per cent) at 260–320° for 8 hr., and the main product isolated after crystallization from benzene–ethanol was found to be *p*-terphenyl (II, melting point 212°; lit.[7] 210–211·5°; lit.[8] 213°; calc. for $C_{18}H_{14}$: C, 93·91; H, 6·08; found: C, 93·74; H, 5·95 per cent). Nitration of *p*-terphenyl, gave the *pp'*-dinitro derivative of *p*-terphenyl (melting point 278–279°; lit.[7] 275°; lit.[12] 277°). Complete separation of *p*-terphenyl left a thick oil which crystallized from ethanol to give *m*-terphenyl (melting point 87–88°; lit.[9] 86–87°; lit.[10] 89°; calc. for $C_{18}H_{14}$: C, 93·91; H, 6·08; found: C, 93·106; H, 5·75 per cent); but attempts to isolate *o*-terphenyl[9] were not successful.



I



II

Reduction of the Friedel–Crafts product by Huang-Minlon's method[11] gave a hydrocarbon (boiling point 170–172°/3 mm.), which on subsequent dehydrogenation by palladized-charcoal (30 per cent) at 260–320° for 8 hr. furnished mainly *p*-terphenyl and a small quantity of *m*-terphenyl; but no *o*-terphenyl could be isolated.

Grignard reaction between methyl-iodide and the ketone I, followed by dehydration of the crude Grignard product with phosphorus pentoxide, gave a liquid hydrocarbon (boiling point 178–180°/3 mm.) which was dehydrogenated by palladized-charcoal (30 per cent) at 260–320° for 8 hr. to give *p*-(2-methyl)-terphenyl (melting point 91–92°, from ethanol; lit.[7,10] 91–92°; calc. for $C_{19}H_{16}$: C, 93·44; H, 6·55; found: C, 93·36; H, 6·46 per cent).

The assignment of the structure I to the Friedel–Crafts reaction product is not above scrutiny, as rearrangement under the drastic condition of dehydrogenation may well have taken place to give *m*- and *p*-substituted products[9]. This finds some support in the isolation from the product of dehydrogenation of a considerable quantity of *m*-terphenyl. However, this point is now receiving consideration.

Microanalyses were carried out by Drs. Weiler and Strauss (Oxford).

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Determination of the Mean Life-time of μ-Mesons

The photographic emulsion method has been applied to the determination of the mean life-time of μ-mesons from their anomalous absorption. Ilford *C* 2 plates with emulsion thicknesses 140 μ, 150 μ and 185 μ were exposed to cosmic radiation under controlled conditions for 42 days during the winter of 1950 in the High Tatra Mountains. One batch of plates was exposed without any absorber at Skalnaté Pleso (1,780 m.) and another one was placed on the top of Lomnický Štít (2,640 m.) under 12 cm. of lead absorber, corresponding in stopping power to the layer of air, 85 gm./cm.², between the two stations. The plates were developed by the freezing method of C. C. Dilworth[1].

The mean life-time τ_0 of μ-mesons was calculated from the formula

$$\tau_0 = \frac{m_0}{p} L, \qquad (1)$$

where m_0 is the rest mass of the μ-meson, p is the effective momentum and L is the mean range before decay. The rest mass of mesons was determined by grain counting and Coulomb scattering methods, giving the result $m_0 = 110$ MeV./c^2. The effective momentum p was calculated by numerical integration of the Bethe–Bloch formula and corrected according to B. Rossi and D. B. Hall[2]. The mean range before decay was calculated from the formula:

$$L = -(H_1 - H_2)\left(\log \frac{N_2}{N_1}\right)^{-1}, \qquad (2)$$

where H_1 is the height of Lomnický Štít, H_2 is the height of Skalnaté Pleso, N_1 is the number of mesons in a given volume of the emulsion from the higher station under lead, N_2 is the number of mesons in the same volume of the emulsion exposed at the lower station.

Substituting the measured and calculated values of m_0, p, and L in formula (1), we obtained for the mean life-time of the μ-meson, $\tau_0 = (2{\cdot}3 \pm 0{\cdot}3) \times 10^{-6}$ sec., in good agreement with the value $\tau_0 = (2{\cdot}15 \pm 0{\cdot}1) \times 10^{-6}$ sec. from direct measurements.

This method makes it possible to work with mesons in the low-energy region where the absorption anomaly[3] is more pronounced and where the polarization of the medium[3] is negligible. Since it is possible to measure the mass m_0 of mesons from the tracks observed, we were able to determine the value of τ_0 directly, whereas using Geiger–Müller counters it is possible to obtain from the anomalous absorption the value of the ratio τ_0/m_0 only. In this way, our measurements show that ρ-mesons are almost exclusively μ-mesons.

A detailed account of this work will be published in the *Bulletin international de l'Académie tchèque des Sciences*. I am indebted to Prof. V. Petržílka for helpful discussions during the course of this work.

J. Pernegr

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Academy of Sciences,
and
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Charles' University,
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July 25.

[1] Dilworth, C. C., Occhialini, G. P. S., and Vermaesen, L., *Bull. Centre Phys. Nuc., Bruxelles*, Note No. 13 *a* (1949).
[2] Rossi, B., and Hall, D. B., *Phys. Rev.*, **59**, 223 (1941).
[3] Fermi, E., *Phys. Rev.*, **57**, 485 (1940).

Nuclear Disintegrations caused by Fast Cosmic-Ray Neutrons in Photographic Emulsions

On the same plates as those described in my previous communication[1], I have studied the relation between the single tracks and the stars, and tried to elucidate the question of their origin. A detailed analysis of 600 stars and of 3,000 single tracks was carried out. My measurements support the assumption that the single tracks are caused mainly by fast neutrons in glancing collision with the nuclei of the emulsion. From the topological distribution of the stars on the plates and from the angular and energy distributions of their prongs (protons, α-particles and recoil tracks), I have shown, applying the results of the evaporation theory[2], that the great majority of the stars are also caused by fast neutrons in glancing collision without the capture of the incident neutrons in the nuclei. The energy distribution of fast protons emitted from stars was used to determine the range of nuclear forces following E. Bagge[3] and G. Ortner[4]. From my measurements I obtained the value $\varkappa^{-1} = (2{\cdot}6 \pm 0{\cdot}4) \times 10^{-13}$ cm.

Details of this work will be published in the *Bulletin international de l'Académie tchèque des Sciences*. I wish to express my gratitude to Prof. V. Petržílka for helpful advice in this work.

J. Pernegr

Institute of Nuclear Physics,
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and
Institute of Physics,
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Prague.
July 25.

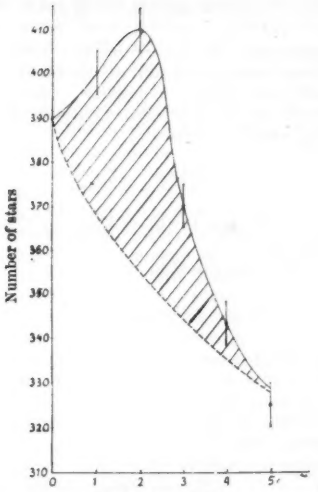
[1] Pernegr, J. (see preceding communication).
[2] Le Couteur, K. J., *Proc. Phys. Soc.*, A, **63**, 259 (1950).
[3] Bagge, E., *Phys. Z.*, **21**, 461 (1944).
[4] Ortner, G., *Ber. Akad. Wien*, **149**, 259 (1940).

Transition Effect of the Star-producing Radiation

To prove the existence of the transition effect of the star-producing radiation suggested by G. Bernardini[1], an experiment relating to this question was carried out in the High Tatras in the winter of 1950. Six batches of Ilford *C* 2 plates with emulsion thickness of 200 μ were exposed during 45 days at Lomnický Štít (2,640 m.). One batch of plates was exposed without any absorber, while the others were placed under different layers of lead of increasing thicknesses from 1 cm. to 5 cm.

The experimental results concerning the numbers of stars observed in the same volumes of the emulsion under different thicknesses of the absorber are plotted in the accompanying graph. Comparison of the experimental values with the postulated exponential absorption curve shows a well-pronounced maximum of the frequency of stars under the layer of about 20 gm./cm.² lead. The dotted exponential line was drawn using the value for the absorption coefficient $\lambda^b = 310$ gm./cm.².

Further observations are being collected, and definite measurements with possible interpretations of this effect will be published later in the *Bulletin international de l'Académie tchèque des Sciences*.



Transition effect of star-producing radiation : – – – –, theoretical exponential absorption ; ———, experimental

I wish to thank Dr. J. Pernegr for suggestions and help in this work.

Note added in proof. Since this communication was written, G. Belliboni, L. Fabrichesi, L. de Marco and M. Merlin[2] have published a paper in which they describe measurements similar to those I have made.

L. Tomášková

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Academy of Sciences,
and
Institute of Physics,
Charles' University,
Prague.
July 25.

[1] Bernardini, G., "Cosmic Radiation", 21, in the Colston Papers (Butterworths Scientific Publications, London, 1949).
[2] *Nuovo Cimento*, **8**, 374 (1951).

The Decay Scheme of Zinc-65

According to a short report given by Good and Peacock[1], the radioactive isotope zinc-65 decays 97·8 per cent by *K*-capture and 2·2 per cent by positron emission. They also found that 54 per cent of the capture processes go directly to the ground-state of the product nucleus copper-65, while 46 per cent go to the 1·11-MeV. excited state.

In the present work, the branching ratio between the two capture processes has been investigated, using a selective method for the detection of the X-rays in addition to X–γ coincidences and a calibrated γ-ray counter.

The source used was a thin layer of finely ground zinc-65 spread on a 'Cellophane' foil and covered with a few drops of a diluted solution of cellulose. This source was placed between two cylindrical Geiger–Müller counters—an ordinary γ-ray counter with 1-mm. thick brass walls, and an X-ray counter with aluminium walls 0·05 mm. thick.

Let K_1 be the number of capture processes going to the ground-state and K_2 the number going to the excited state. Then a branching ratio p can be defined as:

$$p = K_2/(K_1 + K_2). \quad (1)$$

The characteristic X-rays of copper resulting from the K-capture are converted to the extent of about 63 per cent into Auger electrons[2]. As this Auger effect should be of the same magnitude in both branches, p can be written:

$$p = X_2/(X_1 + X_2), \quad (2)$$

where X_1 and X_2 denote the number of X-rays in the two branches.

As the following relation is valid:

$$C = pN_x\,(N_\gamma/N_{0\gamma}), \quad (3)$$

p can be determined from the absolute microcurie γ-strength of the source $N_{0\gamma}$, and from the counting-rates of (i) true X–γ coincidences (C), (ii) X-rays detected in the aluminium counter (N_x), and (iii) γ-rays detected in the brass counter (N_γ). Equation (3) holds exactly provided that there is no internal conversion of γ-rays; the conversion factor for zinc-65 is $2{\cdot}3 \times 10^{-4}$ according to Wagooner *et al.*[3], and is thus negligible in this case.

Concerning the quantities in equation (3), C and N_γ can be measured directly with due correction for background and chance coincidences. $N_{0\gamma}$ was determined from the counting-rates (in the brass counter) obtained respectively from the zinc-65 source and a cobalt-60 standard using identical geometry. However, the value of N_x was difficult to deduce from the measured counting-rate N_{Al} in the thin-walled aluminium counter, because of the simultaneous detection in this counter of positrons and Compton electrons due to γ-quanta.

To avoid these difficulties a selective method was used, based on varying the efficiency of the aluminium counter for X-rays, those for γ- and β-rays remaining constant. The characteristic X-rays of copper (8·05 keV.) are absorbed in the gas only by photo-effect, and this process accounts for the greater part of the counting-rate, the contribution from the walls being relatively small. Therefore the difference of efficiency aimed at is easily achieved by varying the pressure, that is, the absorption probability in the gas, and thus the value of N_x[4]. On the other hand, the yields of γ- and β-rays are scarcely dependent on the gas pressure in the counter, as has been confirmed by special experiments. A somewhat similar method has been described by Gráf[5].

From equation (3) it is clear that, when varying the X-ray efficiency according to the method described, a linear relation between C and N_{Al} is to be expected, since N_{Al} differs from N_x by a nearly constant amount. Thus, the dependence of C on N_{Al} is given by a straight line, and p can be calculated from the slope of this line. Errors in C due to annihilation radiation and scattering are independent of the variation and will thus have no influence on the calculation of p.

The present measurements were carried out at three different pressures of argon, namely, at 90, 270, and 487 mm. of mercury. The results obtained confirm the presumed linearity between C and N_{Al}, and a value of $p = 0{\cdot}44 \pm 0{\cdot}03$ has been found. This is in fair agreement with the value 0·46 given by Good and Peacock.

I wish to express my thanks to Prof. L. Meitner for her help and guidance throughout this work.

Note added in proof (*November* 19). In the meantime, a paper[6] has been published, where zinc-65 is reported to decay to the extent of 0·8 per cent by positron emission.

S. E. Furberg

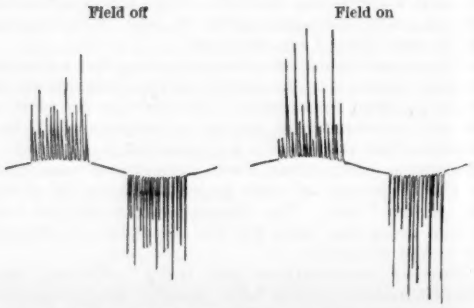
L. Meitner Laboratory,
Royal Institute of Technology,
Stockholm.
Sept. 7.

[1] Good, W. M., and Peacock, W. C., *Phys. Rev.*, **69**, 680 (abs. *B*1) (1946).
[2] Massey, H. S., and Burhop, E. H. S., *Proc. Roy. Soc.*, A, 153, 661 (1936).
[3] Wagooner, M. A., Moon, M. L., and Roberts, A., *Phys. Rev.*, 80, 429 (1950).
[4] Brogren, G., *Ark. Mat., Astr. o. Fysik*, **36 A**, No. 18 (1949).
[5] Gráf, T., *Ark. Fysik*, **3**, No. 13 (1951).
[6] Griffiths, G. M., *Phys. Rev.*, **83**, 852 (1951).

A Magnetic Analogue of the Joshi Effect

Following Joshi's observation[1,2] that the discharge current i due to a potential V depends on $V - V_m$, where V_m is the threshold potential characteristic of a discharge reaction, and that V_m is affected by a transverse magnetic field H, we have carried out some detailed investigations of a change with H of i in several gases and vapours excited in an ozonizer, at various frequencies n.

This effect is found ordinarily to be one of suppression $-(\Delta i)H$, which is remarkably similar to the Joshi effect $-(\Delta i)L$ caused by irradiation from the extreme red[3] to X-rays[4]. Both the light and magnetic effects involve practically a negligible time-lag[5,6], are reversible[6,7], are influenced markedly by 'ageing' under discharge[1,8,9], show hysteresis[9,10] which is maximum near V_m and are affected adversely by heating and by increase of n[11,12]. They cannot be detected below the threshold potential[7,13] V_m, where the discharge current i is entirely capacitative ($2\pi nCV$, C being the distributed capacity), despite the use of intense transverse magnetic field H or irradiation. A limited increase of potential above V_m favours either of the negative effects, magnetic field or irradiation being constant. The range of potentials for the production of the magnetic effect is greater than that for the light effect; the former, however, is detectable at comparatively low pressures. As the transverse magnetic field is increased progressively, $-(\Delta i)H$ first decreases numerically; it is zero at a critical H and then is inverted to $+(\Delta i)H$, a reversible increase of i; this is similar to $+(\Delta i)L$[1,14,15]. Just below V_m, where the discharge current is not 'self-maintained', both $+(\Delta i)L$ and $+(\Delta i)H$ are



Exciting potential, 1·8 kV. r.m.s. (50 c./s.); p_{H_2}, 0·04 mm. mercury; H, 880 gauss; current change due to H, −29 per cent

observed under feeble light[1,13] and magnetic field[16,17] respectively. At a given potential V, either of the transitions[14-17] $-(\Delta i)L,H \rightleftharpoons +(\Delta i)L,H$ can be caused *ad libitum* by varying the transverse magnetic field H or the intensity and frequency of light.

Both the light and magnetic effects are linked preferentially with the high-frequency component[5,7,11,12] of the discharge current i. The accompanying pair of oscillograms refers to a discharge in low-pressure hydrogen; essentially similar results are obtained in a number of media with a wide range of operative conditions. On the application of the transverse magnetic field in either half of the current cycle, the amplitude of some of the high-frequency spikes is reduced while that of others increased simultaneously; this is accompanied usually, though not invariably, by a change in the number of high-frequency spikes. A like effect, namely, simultaneous occurrence of $\pm(\Delta i)L$ in different parts of the current cycle, was observed in chlorine[10] and iodine vapour[18].

Our thanks are due to Prof. S. S. Joshi, of Benares, and Prof. V. N. Thatte, of Nagpur, for help and advice.

M. R. Bhiday
V. G. Bhide
G. V. Asolkar

Department of Physics,
College of Science,
Nagpur.
May 10.

[1] Joshi, Pres. Addr. Chem. Sec. Ind. Sci. Cong., 1943.
[2] Joshi, *Curr. Sci.*, **8**, 548 (1939).
[3] Joshi, *Curr. Sci.*, **14**, 317 (1945).
[4] Joshi, *Curr. Sci.*, **13**, 278 (1944).
[5] Joshi, *Nature*, **154**, 147 (1944).
[6] Joshi, *Curr. Sci.*, **13**, 253 (1944).
[7] Joshi, *Proc. Ind. Acad. Sci.*, **22**, 227 (1945)
[8] Joshi, *Banaras Univ. J.*, **8**, 99 (1943).
[9] Marathe and Bommannavar, *Nature*, **165**, 891 (1950).
[10] Joshi, Proc. Ind. Sci. Cong., Phys. Sec., Abst. 25 (1947).
[11] Joshi, *Proc. Ind. Acad. Sci.*, **22**, 225 (1945).
[12] Joshi, *Curr. Sci.*, **14**, 67 (1945).
[13] Joshi, and Lad, *Proc. Ind. Acad. Sci.*, **22**, 293 (1945).
[14] Joshi, *Curr. Sci.*, **16**, 19 (1947).
[15] Ramanamurti, Proc. Ind. Sci. Cong., 1950, Phys. Sec., **Abst.** 50. Arvikar, *ibid.*, Abst. 44.
[16] Bhiday, Bhide and Asolkar, Proc. Ind. Sci. Cong., Phys. Sec., Abst. 61 (1950).
[17] Bhiday, Bhide and Asolkar, Proc. Ind. Sci. Cong., Phys. Sec., Abst. 38 (1951).
[18] Jatar, *J. Sci. Ind. Research*, **9**, B, 285 (1950).

Formula for Creep Curves of Metals

I was somewhat surprised to read in *Nature* of October 20 the letter of Prof. R. R. Hasiguti and his collaborator. Prof. Hasiguti sent me a copy of this letter in April and I replied to him on May 25, by air mail, pointing out that the only reason that he found that the four-constant formula, put forward by him, gave a better fit to his experimental results than my three-constant formula was that he had taken unfavourable values for the constants in my formula. I sent him the correct values of the constants, found by the method of Dr. A. J. Kennedy[1], which are $l_0 = 49{\cdot}57$ cm.; $\beta = 1{\cdot}1006 \times 10^{-2}$ sec.$^{-1/3}$; $\varkappa = 1{\cdot}4713 \times 10^{-4}$ sec.$^{-1}$. With these values, the "Length calculated from Andrade's formula" in Table 1 given in his letter come out to be 50·71, 51·35, 53·16, 57·30, 65·00. Prof. Hasiguti sent me in his original letter a much fuller list of values than that given in his Table 1, and, except at 7 sec., where the experimental reading cannot possibly be accurate (in view of the difficulty of deciding to within a second the moment of imposition of the load, inertia effects and the rapid rate of flow in the first ten seconds), the greatest difference between the values given by my equation and the experimental values was 0·08 per cent as against a greatest difference of 0·10 per cent with his equation. In fact, with the constants given above, my three-constant formula shows a better fit than his four-constant formula.

Unfortunately, the writers of the letter printed in *Nature* do not give the values of their four constants that lead to the figures for s given in their Table 1, and Dr. Kennedy has, after some effort, been unable to find values that yield these figures.

The validity of my formula has been often verified, both inside and outside my Laboratory[2], and it is recognized that the constants β and $\varkappa$ represent definite physical processes, β accounting for slip within the crystal grains of the polycrystalline metal and $\varkappa$ for relative movement of the grains[3]. The constants a, b, c in the four-constant formula appear to have no physical significance.

As far as the single crystal results are concerned, Cottrell and Aytekin[4] found very good agreement between their experimental result on single crystals of zinc and the formula

$$\gamma = \gamma_0 + \beta t^{1/3} + \varkappa t,$$

which is the appropriate form of my formula for a single crystal. As a purely empirical result, Dr. Kennedy has pointed out to me that the experimental results given in Prof. Hasiguti's Table 2 are much better fitted by the two-constant formula $\gamma = \gamma_0 t^{0{\cdot}615}$ than by Prof. Hasiguti's four-constant formula.

E. N. da C. Andrade

Davy Faraday Research Laboratory,
21 Albemarle Street,
London, W.1.
Nov. 12.

[1] Kennedy, A. J., *Proc. Phys. Soc.*, **61**, 510 (1948).
[2] For example, Andrade, E. N. da C., *Proc. Roy. Soc.*, A, **84**, 1 (1910); **90**, 329 (1914). Andrade, E. N. da C., and Chalmers, B., *Proc. Roy. Soc.*, A, **138**, 348 (1932). Latin, A., *J. Inst. Metals*, **74**, 259 (1948). Hopkin, L. M. T., *Proc. Phys. Soc.*, **63**, 346 (1950).
[3] For example, Orowan, E., *J. West of Scotland Iron and Steel Inst.* (1946-47).
[4] Cottrell, A. H., and Aytekin, V., *J. Inst. Metals*, **77**, 389 (1950).

"The Home Life of an Astronomer"

I am very grateful to Prof. F. J. M. Stratton for his appreciative review of my book, "Ninth Astronomer Royal"[1], but I do not understand his saying that I have ascribed Einstein's special theory of relativity to Newton. Unless there is some error that has escaped my notice, this must refer to the statements on page 192: "According to the new Theory of Relativity the rays of light from these stars would be bent in passing the huge mass of the sun. This deflection would be twice as great as anything that could be accounted for by the old Newtonian theory. . . . Would it be the 1·74 seconds of arc indicated by Einstein's theory, or the 0·87 seconds of arc indicated by Newton's, or none at all?" Does this attribute the special theory of relativity to Newton? If so, I err in good company, that of Sir Arthur

Eddington, who writes in "Space, Time and Gravitation": "It must be understood that there were two questions to answer: first, whether light has weight (as suggested by Newton), or is indifferent to gravitation; secondly, if it has weight, is the amount of the deflection in accordance with Einstein's or Newton's laws?" (page 110). Further, "It will be remembered that Einstein's theory predicts a deflection of 1″·74. . . . The simple Newtonian deflection is half this, 0″·87" (page 118).

I gladly admit that I am not competent to do justice to my father's scientific work, but I took the precaution of asking astronomical and other scientific friends to check my manuscript, so I shall be surprised if there are any definite errors of statement on scientific matters in my book. In other respects, the review is only too kind.

Margaret Wilson

The Chimes,
Radford Rise,
Stafford.

[1] *Nature*, **168**, 440 (1951).

The use of the words "old Newtonian theory" in connexion with the value of the deflexion of light rays passing close to the sun predicted by Einstein's restricted theory of relativity was the cause of the critical remark of which Mrs. Wilson complains. Newton never developed any theory of the bending of light. He did raise a query whether bodies could bend rays of light. This was one of 22 which he propounded, but left to posterity to follow up. Eddington's reference to the value to be expected for the deflexion according to Newton's laws of gravitation is correct in form; his subsequent statement that "Newton's theory suggests no means for bringing about the bending but contents itself with predicting it on general principles" is misleading and accounts for the reference to "Newton's theory" criticized in my review.

F. J. M. Stratton

Gonville and Caius College,
Cambridge.

The Clear Representation of Very Small Masses

Many methods are used for representing small masses; some are not readily legible and others are not immediately comprehensible to those unfamiliar with the notation. Since few editors seem to have a settled policy in this matter, it may be profitable to set out some of the considerations involved.

Two main courses can be followed: we can use one unit of mass, such as the gram, and multiply it by a suitably expressed but complex number; or we can use a series of subunits, such as the milli- and micro-gram, and multiply by a simple number. When the first method was used in the older literature, we often had a long row of 0s. Now we generally have a simple number multiplied by 10 with a negative index, or a neater logarithmic form is used and the whole quantity appears in a negative non-integral index. The latter form has the advantage, shared by the *p*H notation, etc., that biological response often varies with the logarithm of a quantity rather than with the quantity itself, so that equal numerical intervals in the index correspond to similar changes in response. Each form has the defect that the most important part of the whole quantity, the index, is the least easily legible. With good printing and paper, one can by peering make out the quantity, but many publications now appear 'on grey paper with blunt type' and then the quantity can be lost irrevocably.

A new typographical convention is needed so that any number can be expressed briefly with type of normal size and on the line. The precise convention is a matter of detail which may await decision on the principle, but a strong case can be made for the general use of the prefix *p* to qualify any unit, as it qualifies hydrogen ion concentration in *p*H, and indicate that the number following is a negative logarithm.

Most microanalytical needs are satisfied by the subunits milligram and microgram. This sequence has now been[1] extended by the nanogram (ng = 10^{-9} g) and picogram (pg = 10^{-12} g), and it can be logically extended further to the picopicogram (ppg = 10^{-24} g). With such a unit we have reached atomic dimensions, for the carbon atom weighs 2×10^{-23} g or 20 ppg. By judicious use of a subunit, any mass can therefore be expressed by a simple number and there is no need ever to use indices or logarithmic notation at all.

The biologist is sometimes concerned with a small mass; but he is more often concerned with concentrations, so that both mass and volume are being specified. Here simplicity should surely be aimed at and, by the use of units of concentration such as mg or μg per litre, indices and complex numbers should be avoided. In terms of molarity we do not have quite the same flexibility; but even here the more cumbrous forms can be avoided by using m*M* and μ*M*. Few substances with definable molecular weights exert much action at the latter dilution.

There are obvious advantages in taking one-sixteenth of the mass of an oxygen atom as a unit. Various names and symbols have been proposed for this; for example, h [2], the Cannizzaro unit[3] and the Dalton (d) [4]. With such a unit, molecular masses have the same numerical form as the conventional molecular weight ratios, and there is no advantage in introducing a unit when small molecules are under consideration. But with not readily separable mixtures, for example, the higher fatty acids, the use of a unit increases the precision of a statement without the appearance of too much pedantry. The larger and the less well defined the particle the stronger becomes the case for a mass unit. Thus the application of the unqualified term 'molecular weight' to a protein may lead to a false certainty about what has been demonstrated. This can be avoided by some such phrase as 'particles of median mass 200,000 d or 0·2 Md'.

The points raised here can be summarized in the form of three complementary questions on which I invite comment. Do the advantages of avoiding indices outweigh the difficulties of establishing a new typographical convention? Is pico- a useful prefix, and should editors urge authors to use subunits wherever possible? Is the Dalton (d = 1/16 the mass of an oxygen atom = $1{\cdot}65 \times 10^{-24}$ g) an acceptable and useful unit of mass?

N. W. Pirie

Rothamsted Experimental Station,
Harpenden, Herts.

[1] A Report by the Symbols Committee of the Royal Society (1951).
[2] Pirie, *Biol. Rev.*, **15**, 377 (1940).
[3] Sborgi, *Gazz. chim. ital.*, **15**, 293 (1942).
[4] Landolt-Börnstein, "Tabellen" (19[illegible]).

FORTHCOMING EVENTS

*(Meetings marked with an asterisk * are open to the public)*

Saturday, December 8

NORTH OF ENGLAND INSTITUTE OF MINING AND MECHANICAL ENGINEERS (at Neville Hall, Newcastle-upon-Tyne), at 2.30 p.m.—Mr. F. A. Dixon: "Town and Country Planning in relation to Coal Industry Activities".

Monday, December 10

ROYAL GEOGRAPHICAL SOCIETY (at 1 Kensington Gore, London, S.W.7), at 5 p.m.—Mr. W. G. V. Balchin: "Erosion Surfaces of the Exmoor Area".

BRITISH SOCIETY FOR THE HISTORY OF SCIENCE, PHILOSOPHY OF SCIENCE GROUP (in the Council Room, University College, Gower Street, London, W.C.1), at 5.30 p.m.—Prof. R. O. Kapp: "Problems and Theories of Causation".

MANCHESTER LITERARY AND PHILOSOPHICAL SOCIETY (in the Reynolds Hall, College of Technology, Manchester), at 5.30 p.m.—Sir Frederic Bartlett, F.R.S.: "Thinking". (Clayton Memorial Lecture.)*

INSTITUTION OF ELECTRICAL ENGINEERS (at Savoy Place, Victoria Embankment, London, W.C.2), at 7 p.m.—Mr. D. H. Homis and Mr. R. J. Ryan: "The Van de Graaff Generator as a Million Volt D.C. Source".

Tuesday, December 11

SOCIETY OF CHEMICAL INDUSTRY, AGRICULTURE GROUP (in the Chemistry Lecture Theatre, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—Mr. T. P. Dee and Dr. Rice Williams: "Alternative Phosphatic Fertilizers".*

ZOOLOGICAL SOCIETY OF LONDON (at the Zoological Gardens, Regent's Park, London, N.W.8), at 5 p.m.—Scientific Papers.

INSTITUTION OF ELECTRICAL ENGINEERS, MEASUREMENTS SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Dr. Pei-Su Hsia: "A Graphical Analysis for Non-linear Systems"; Mr. J. C. West: "A System Utilizing Coarse and Fine Position Measuring Elements simultaneously in R.P.C. Servo-Mechanisms".

ROYAL SOCIETY OF MEDICINE, EXPERIMENTAL MEDICINE SECTION (at 1 Wimpole Street, London, W.1), at 5.30 p.m.—Sir Howard Florey, F.R.S.: "Some Problems in the Chemotherapy of Tuberculosis" (W. E. Dixon Lecture).

SOCIETY OF CHEMICAL INDUSTRY, CHEMICAL ENGINEERING GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Mr. H. Birchall: "The Planning of Maintenance in Chemical Works".

ILLUMINATING ENGINEERING SOCIETY (at the E.L.M.A. Lighting Service Bureau, 2 Savoy Hill, London, W.C.2), at 6 p.m.—Mr. W. J. Wellwood Ferguson: "Dark Adaptation and Miners' Nystagmus".

MANCHESTER GEOGRAPHICAL SOCIETY (at the Geographical Hall, 16 St. Mary's Parsonage, Manchester), at 6.30 p.m.—The Rt. Hon. A. Creech Jones: "Some Problems in African Development".

SHEFFIELD METALLURGICAL ASSOCIATION (at the Grand Hotel, Sheffield), at 7 p.m.—Mr. H. C. Child: "Resistance of Gas Turbine Alloys to Scaling and Vanadium Attack"; Dr. L. G. Finch: "The Evaluation of Residual Stresses in Metals by X-rays".

Wednesday, December 12

IRON AND STEEL INSTITUTE (joint meeting with the BRITISH IRON AND STEEL RESEARCH ASSOCIATION and the CORROSION GROUP of the SOCIETY OF CHEMICAL INDUSTRY, at the Institution of Electrical Engineers, Savoy Place, Victoria Embankment, London, W.C.2), at 10 a.m.—Symposium on "The Corrosion of Buried Metals".

INSTITUTE OF FUEL, NORTH-WESTERN SECTION (at the Engineers' Club, Albert Square, Manchester), at 2 p.m.—Dr. A. C. Monkhouse: "Progress in Domestic Heating Research".

ROYAL SANITARY INSTITUTE (at 90 Buckingham Palace Road, London, S.W.1), at 2.30 p.m.—Discussion on "Prevention of Damage by Pests—Progress of Rodent Control" (to be opened by Mr. W. McAuley Gracie).

ROYAL SOCIETY OF ARTS (at John Adam Street, Adelphi, London, W.C.2), at 2.30 p.m.—Dr. Charles Hill: "Food and Fads" (Armstrong Memorial Lecture).

GEOLOGICAL SOCIETY OF LONDON (at Burlington House, Piccadilly, London, W.1), at 5 p.m.—Scientific Papers.

INSTITUTE OF PETROLEUM (at Manson House, 26 Portland Place, London, W.1), at 5.30 p.m.—Prof. F. H. Garner, Prof. F. Morton, Mr. W. D. Reid, Dr. A. H. Nissan, Dr. E. P. Wright and Mr. W. E. Malpas: "Pre-Flame Reactions in Diesel Engines".

INSTITUTION OF ELECTRICAL ENGINEERS, EDUCATION DISCUSSION CIRCLE (at Savoy Place, Victoria Embankment, London, W.C.2), at 6 p.m.—Discussion on "Activity Methods in Technical Education" (to be opened by Mr. R. D. Watts).

SOCIETY OF CHEMICAL INDUSTRY, NUTRITION PANEL of the FOOD GROUP (at the Chemical Society, Burlington House, Piccadilly, London, W.1), at 6.15 p.m.—Discussion on "Sugar". (Mr. H. S. C. De Whalley: "Its Production, Purification and By-products"; Dr. R. D. Lawrence: "Its Place in the Dietary—Normal and Abnormal Metabolism".)

Thursday, December 13

PHYSICAL SOCIETY, OPTICAL GROUP (in the Physics Department, Imperial College of Science and Technology, Imperial Institute Road, London, S.W.7), at 2.30 p.m.—Scientific Papers.

CHADWICK PUBLIC LECTURE (in the Wright Fleming Institute of Microbiology, St. Mary's Hospital Medical School, Norfolk Place, London, W.2), at 4.30 p.m.—Prof. Robert Cruickshank: "The Epidemiology of some Skin Infections" (Malcolm Morris Memorial Lecture).*

ROYAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Dr. C. H. Andrewes, F.R.S.: "The Place of Viruses in Nature" (Leeuwenhoek Lecture).

ROYAL SOCIETY OF ARTS, COMMONWEALTH SECTION (at John Adam Street, Adelphi, London, W.C.2), at 5.15 p.m.—Dr. V. E. Fuchs: "The Falkland Islands Dependencies Survey".

INSTITUTION OF ELECTRICAL ENGINEERS, UTILIZATION SECTION (at Savoy Place, Victoria Embankment, London, W.C.2), at 5.30 p.m.—Mr. P. Bingley: "The Characteristics and Control of Rectifier-Motor Variable-Speed Drives".

BRITISH INSTITUTION OF RADIO ENGINEERS (at the London School of Hygiene and Tropical Medicine, Keppel Street, London, W.C.1), at 6.30 p.m.—Dr. W. Grey Walter and Mr. H. W. Shipton: "Electronic Analogues of Physiological Processes".

CHEMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 7.30 p.m.—Prof. D. H. Hey: "Some Recent Developments in the Chemistry of Free Radical Reactions in Solution" (Tilden Lecture).

ROYAL SOCIETY OF TROPICAL MEDICINE AND HYGIENE (at Manson House, 26 Portland Place, London, W.1), at 7.30 p.m.—Dr. D. B. Jelliffe: "The African Child".

Friday, December 14

TEXTILE INSTITUTE, LANCASHIRE SECTION (at 16 St. Mary's Parsonage, Manchester), at 1 p.m.—Mr. J. W. Illingworth: "Textiles in the Rubber Industry".

BIOCHEMICAL SOCIETY (at Guy's Hospital Medical School, London Bridge, London, S.E.1), at 2 p.m.—Scientific Papers.

ROYAL ASTRONOMICAL SOCIETY (at Burlington House, Piccadilly, London, W.1), at 4.30 p.m.—Scientific Papers.

EUGENICS SOCIETY (at the Royal Society, Burlington House, Piccadilly, London, W.1), at 5.30 p.m.—Dr. C. P. Blacker: "Eugenic Experiments conducted by the Nazis on Human Subjects".*

INSTITUTION OF MECHANICAL ENGINEERS (joint meeting with the HYDRAULICS GROUP, at Storey's Gate, St. James's Park, London, S.W.1), at 5.30 p.m.—Mr. A. E. Bingham: "Some Problems of Fluids for Hydraulic Power Transmission"; Mr. B. Cooke: "Low Pressure Reciprocating Seals for Hydraulic Control Valves".

MANCHESTER STATISTICAL SOCIETY, INDUSTRIAL STUDY GROUP (at the Albert Hall, Peter Street, Manchester), at 6.45 p.m.—Mr. D. H. Ward: "Statistical Tests in the Comparison of Laboratories".

INSTITUTE OF PHYSICS, MANCHESTER AND DISTRICT BRANCH (in the New Physics Theatre, The University, Manchester), at 7 p.m.—Dr. J. Weston: "Full-scale Heating Research".

SOCIETY OF CHEMICAL INDUSTRY, FINE CHEMICALS GROUP (in the Chemistry Lecture Theatre, King's College, Strand, London, W.C.2), at 7.30 p.m.—Discussion on "Glass Plant in Industry and Research" (introduced by Mr. B. H. Turpin).

ROYAL INSTITUTION (at 21 Albemarle Street, London, W.1), at 9 p.m.—Prof. E. N. da C. Andrade, F.R.S.: "The Mechanics of Metal Crystals".

APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

LECTURER (with an honours degree in electrical engineering, and research interests in electronics or radio communications field) IN THE DEPARTMENT OF ENGINEERING—The Secretary, The University, Edinburgh (December 14).

ASSISTANT (Grade A) TO TEACH ENGINEERING SUBJECTS (Mathematics, Drawing and Workshop Technology) to the standard of Inter. City and Guilds (Machine Shop Engineering), at Pudsey Technical Institute—The Divisional Education Officer, Education Offices, Richardshaw Lane, Pudsey, Leeds (December 15).

ASSISTANT (Grade A) IN THE MECHANICAL ENGINEERING DEPARTMENT, South Shields Marine and Technical College—The Director of Education, Town Hall, South Shields (December 15).

HEAD OF THE MATHEMATICS DEPARTMENT, Coventry Technical College—The Director of Education, Council House, Coventry (December 15).

SENIOR SCIENTIFIC OFFICER (with an honours degree in biochemistry, and research experience) IN THE BIOCHEMISTRY DEPARTMENT, and a SCIENTIFIC OFFICER (with an honours degree in chemistry) IN THE TECHNICAL CHEMISTRY DEPARTMENT—The Secretary, Hannah Dairy Research Institute, Kirkhill, Ayr (December 17).

SENIOR SCIENTIFIC OFFICERS (4) IN THE RESEARCH AND DEVELOPMENT BRANCH at the Electronics Research Laboratory at Adelaide, South Australia, to be responsible to a Principal Scientific Officer for the detailed direction of the work of a team engaged on research and development for new defence equipment in the field of radio, radar and allied techniques—The Senior Representative, Department of Supply, Canberra House, 87 Jermyn Street, London, S.W.1 (December 19).

HYDRO-ELECTRIC ENGINEERING CONSULTANT for the Thal Development Authority, Punjab Province, Pakistan, under the Commonwealth Technical Co-operation Scheme for South and South-East Asia—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting D.477/51.OA (December 22).

PHYSICIST (N.H.S. Senior grade), to develop a clinical radioactive isotope service for the hospital, and to carry out research on related biological problems—The Secretary and House Governor, Mount Vernon Hospital and the Radium Institute, Northwood, Middx. (December 22).

RESEARCH DIRECTOR (with high academic qualifications and considerable experience in leading research) for a new large textile research association at Ahmedabad, Bombay State—The Scientific Adviser to the High Commission, India House, Aldwych, London, W.C.2 (December 22).

SENIOR LECTURER IN THE DEPARTMENT OF VETERINARY PATHOLOGY—The Secretary of University Court, The University, Glasgow (December 22).

TEXTILE TECHNOLOGIST (with good professional qualifications and research or practical experience in spinning, weaving or wet processing) as HEAD OF THE TEXTILE TECHNOLOGY DIVISION of a new large textile research association at Ahmedabad, Bombay State—The Scientific Adviser to the High Commission, India House, Aldwych, London, W.C.2 (December 22).

ASSISTANT KEEPER IN THE DEPARTMENT OF BIOLOGY—The Director, Museums and Art Gallery, New Walk, Leicester (December 31).

CYTOLOGIST (with experience in cancer work; medical qualification not necessary)—The Secretary and House Governor, Mount Vernon Hospital and the Radium Institute, Northwood, Middx. (December 31).

PHYSICAL CHEMIST and an ORGANIC CHEMIST in the Section of Insecticides and Fungicides at the Long Ashton Research Station—The Registrar and Secretary, The University, Bristol (December 31).

PROFESSOR OF ECONOMICS—The Secretary and Registrar, University College of North Wales, Bangor (December 31).

ASSISTANT HEATING ENGINEER in the County Architect's Department—The County Architect, The Castle, Winchester (January 1).

BACTERIOLOGIST at the Institute of Medical and Veterinary Science, South Australia—The Agent-General and Trade Commissioner for South Australia, Marble Arch, London, W.1 (January 2).

ASSISTANT INSPECTORS OF ANCIENT MONUMENTS (with a University honours degree and enthusiasm for archæology, preferably with some practical experience)—The Secretary, Civil Service Commission, 6 Burlington Gardens, London, W.1, quoting No. 4106/52 (January 3).

ENGINEERING INSPECTOR IN THE ELECTRICITY DIVISION of the Ministry of Fuel and Power—The Civil Service Commission, Scientific Branch, Trinidad House, Old Burlington Street, London, W.1, quoting S.4105/52 (January 3).

ASSISTANT LECTURER OR LECTURER IN THE DEPARTMENT OF BOTANY—The Secretary and Registrar, University College of North Wales, Bangor (January 15).

CHAIR OF PHYSICS in the University of Natal, Pietermaritzburg and Durban—The Secretary, Association of Universities of the British Commonwealth, 5 Gordon Square, London, W.C.1 (January 15).

LECTURER OR ASSISTANT LECTURER IN ZOOLOGY OR BOTANY—The Secretary, Girton College, Cambridge (January 25).

AERODYNAMICISTS for research and development work in the Aerodynamics Department of the Royal Aircraft Establishment, Farnborough, and at a Ministry of Supply research establishment in Bedfordshire: SCIENTIFIC OFFICER (Ref. C.722/51A) for aerodynamics research including experimental work in flight, in subsonic and supersonic wind tunnels and general theoretical work; EXPERIMENTAL OFFICERS and ASSISTANT EXPERIMENTAL OFFICERS (Ref. C.723/51A) for experimental work in flight and in subsonic and supersonic wind tunnels, etc.—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting the appropriate Ref. No.

ASSISTANT (Grade B) IN THE ELECTRICAL ENGINEERING DEPARTMENT—The Registrar, Municipal College, Portsmouth.

ASSISTANT LECTURER TO TEACH ELECTRICAL INSTALLATION work leading to the Course B and Course C examinations of the City and Guilds of London Institute, a LECTURER TO TEACH BOTANY AND ZOOLOGY to Inter.B.Sc. students and CHEMISTRY AND GENERAL SCIENCE to students of foodstuffs, and a LECTURER TO TEACH CHEMISTRY, BIOLOGY AND GENERAL SCIENCE to students of foodstuffs—The Principal, Borough Polytechnic, Borough Road, London, S.E.1.

ASSISTANT METEOROLOGISTS in Nigeria—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27118/5/51.

CIVIL ENGINEERS (Main grade) (Ref. E.251/51A) and ASSISTANT CIVIL ENGINEERS (Recruitment grade) (Ref. E.252/51A) in the Air Ministry Directorate General of Works in London and the Provinces—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting the appropriate Ref. No.

ELECTRICAL ENGINEER (corporate member of the I.E.E. with considerable experience in steam power stations and distribution, with knowledge of normal chemical analysis) in the Electrical Services Department, Nyasaland—The Director of Recruitment (Colonial Service), Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1, quoting 27326/50.

ELECTRICAL ENGINEERS and PHYSICISTS (Scientific Officer grade (Ref. A.366/51A) and Experimental Officer grade (Ref. D.523/51A)) at a Ministry of Supply research and development establishment in the South Midlands, for work on Army radar equipment—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting the appropriate Ref. No.

ELECTRICAL AND MECHANICAL ENGINEERS (Senior Scientific Officer grade) at a Ministry of Supply Design Establishment in the South-East of London: ELECTRICAL ENGINEER (Ref. D.511/51A) for the design and development of remote power controlled gear and servo systems; MECHANICAL ENGINEER (Ref. C.701/51A) for basic development of new projectiles and projectile systems; ELECTRICAL ENGINEER (Ref. D.512/51A) for work on instrumentation for measurement of pressures, stresses, vibration, etc., and for the design of trials apparatus—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting the appropriate Ref. No.

ELIZABETH MACADAM RESEARCH FELLOWSHIP for research into the aetiology and pathogenesis of osteoarthritis and/or the aetiology and pathogenesis of spondylitis ankylopoietica—The General Secretary, Empire Rheumatism Council, Tavistock House (N), Tavistock Square, London, W.C.1.

ENGINEER at a Ministry of Supply establishment, Farnborough, to control a small team dealing with, and be technically responsible for, the development of high-precision components for use in servo systems, and for liaison work within the industry—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting D.517/51A.

ENGINEER at a Ministry of Supply establishment at Hayes Middlesex, to control section responsible for the technical direction of inspection of mass-produced miniature electronic devices—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting D.518/51A.

ENGINEER at the Ministry of Supply Factory at Capenhurst, Chester, to be responsible for the planning, progress and inspection work associated with the operation of a large factory—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs., quoting Ref. 272.

ENGINEER by the Ministry of Supply in London, to assist in planning and progressing production of electronic fuses and specialized thermionic devices—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting D.516/51A.

LECTURER IN THE SCIENCE DEPARTMENT (duties include the teaching of Chemistry to A.R.I.C. level to part-time day and evening students), St. Helens Municipal Technical College—The Director of Education, Education Office, St. Helens.

LECTURER (Grade B) IN PHYSICS—The Clerk to the Governing Body, Battersea Polytechnic, Battersea, London, S.W.11.

MATHEMATICIANS at a Ministry of Supply research and development establishment in the South-East of London: SENIOR EXPERIMENTAL OFFICER OR EXPERIMENTAL OFFICER to take charge of, organize and build up a small computing section; EXPERIMENTAL OFFICER OR ASSISTANT EXPERIMENTAL OFFICER with interest in applied mathematics or numerical analysis—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting A.254/51A.

MATHEMATICIANS AND PHYSICISTS (Senior Scientific Officer grade) at Ministry of Supply Design Establishments in Kent and Sussex: MATHEMATICIAN OR MATHEMATICAL PHYSICIST (Ref. A.360/51A) preferably with knowledge of statistical methods for analysis work in connexion with assessment of weapons performance; PHYSICIST (Ref. A.361/51A) with knowledge of optical and photographic work for scientific direction of Instrumentation Group; PHYSICIST (Ref. A.362/51A) for the determination of rheological characteristics of fuels—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting the appropriate Ref. No.

ORGANIC CHEMIST with experience in microchemistry (preferably with isotopes) to collaborate in biochemical and biophysical research—The Secretary, Middlesex Hospital Medical School, London, W.1.

PHYSICISTS and PHYSICAL OR INORGANIC CHEMISTS at the Ministry of Supply Factory at Capenhurst, Chester, to supervise and participate in the work of a small team engaged in research and development—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, quoting Ref. 268.

PRINCIPAL SCIENTIFIC OFFICER at the Ministry of Supply London headquarters, to assist in the formulation, co-ordination and progressing of the research and development programme in Industry and at Government Establishments in connexion with propulsive units for guided weapons—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting C.706/51A.

PRODUCTION CHEMISTS for Royal Ordnance Factories in Irvine, Bishopton, Chorley, Swynnerton, Glascoed, Pembrey, Bridgwater, Thorp Arch, London headquarters of the Ministry of Supply, and elsewhere, to assist in technical control or administration of explosives and acids manufacture or ammunition filling, including development work—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26–28 King Street, London, S.W.1, quoting F.542/51A.

SENIOR INTELLIGENCE OFFICERS (with a basis of scientific training, plus wide experience in technical information service and/or training in librarianship) in the Library and Intelligence Division—The Secretary, Research Association of British Rubber Manufacturers, 105 Lansdowne Road, Croydon.

SENIOR WELDING ENGINEER IN THE RESEARCH AND DEVELOPMENT BRANCH, Windscale Works, Sellafield, Cumberland, to conduct investigations into welding techniques of non-ferrous and ferrous materials—The Ministry of Supply, Division of Atomic Energy (Production), Risley, Warrington, Lancs, quoting No. 275.

ZOOLOGIST (with at least a second-class honours degree in zoology of U.K. University and, preferably, postgraduate experience) to work at the Zoological Gardens, London, on Fact-Finding Survey of Literature on African Fauna—The Under-Secretary of State (S.610), Research Department, Colonial Office, Sanctuary Buildings, Great Smith Street, London, S.W.1.

REPORTS and other PUBLICATIONS

(not included in the monthly Books Supplement)

Other Countries

Southern Rhodesia. Rainfall Handbook. Prepared by the Department of Meteorological Services. Pp. 30. 7*s.* 6*d.* Rainfall Handbook Supplement No. 1: Totals of Monthly and Annual Rainfall for Stations in the Eastern Area. Prepared by the Department of Meteorological Services. Pp. 55. 2*s.* 6*d.* (Salisbury: Government Printing and Stationery Department, 1951.) [179

City of Durban: Durban Museum and Art Gallery. Annual Report for Municipal Year 1949–1950. Pp. 8. (Durban: Durban Museum and Art Gallery, 1951.) [179

Phyton: International Journal of Experimental Botany. Vol. 1, No. 1, Julio. Pp. ii+46. (Montevideo and Vicente Lopez (Bs.As.): Domus Plantarum, 1951.) Annual subscription, 20*s.*; 3 U.S. dollars. [179